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Motions of Stars in the Scattered Cluster N.G.C. 225.

By Dr. Oliver J. Lee. (Plate 16.)

This group of relatively bright stars is situated not far from the centre of the constellation Cassiopeia. Its position for 1900 is $0^h\ 37^m{\cdot}6 + 61^\circ\ 15'$. Its description in N.G.C. is Cl, L, lC, St 9–10. This position and description refer, however, only to the East end of a larger pear-shaped structure, whose main axis, lying roughly East and West, is about 44′ in length. The maximum width is 36′. The early plate, taken by Schlesinger with the 40-inch Yerkes refractor in 1903, has the N.G.C. group near the centre. The later plate was oriented similarly. In consequence the West end of the larger group was lost. The data reported in this paper cover little more than the eastern half, which is the stem end, of the whole cluster. The plate which is reproduced is a sixfold enlargement of a negative made by Barnard with the $6\frac{1}{4}$-inch doublet of the Bruce telescope on 1904 November 3, with an exposure of $8^h\ 46^m$. It shows the larger group and its environs. The small white rectangle shows the extent of the field on the plate taken with the 40-inch telescope.

Two exposures on the West end will be made with the 40-inch telescope at the earliest opportunity as a foundation for further study of motions in this group.

The data for the two plates used in this investigation are as follows:—

Observer.	No.	Date.	Exp. Time.	H.A.	Definition.	Steadiness.
Schlesinger	92	1903 Sept. 17	30	1 : 50 E	3	3
Lee	6744	1925 Dec. 29	32	0 : 04 E	2	2

The difference in epoch of the two plates is 22·28 years.

The first plate was taken without a colour filter. Both negatives were made on Cramer Isochromatic plates. A figure 5 in the last two columns would indicate perfect atmospheric definition or steadiness.

Each plate was oriented to the epoch 1900 and was measured in the manner described in my work on the Selected Areas.* That is, the plate was measured rather quickly twice in each of four positions. Whenever the difference between the two sets of measures equalled or exceeded ·025 quarter millimetres this fact was noted by the recorder and a third measure was made immediately. Sometimes one of the three was discarded ; more often the mean of all three was taken.

From a careful examination of Barnard's plate it seemed rather probable that the cluster structure is confined to the brighter stars and that therefore the fainter stars anywhere on the plate might serve for comparison stars. Ten were accordingly chosen. Apparently the choice was as good as could be made *a priori*. The same ten comparison stars have been used in all the solutions. Three pairs of solutions were made :—

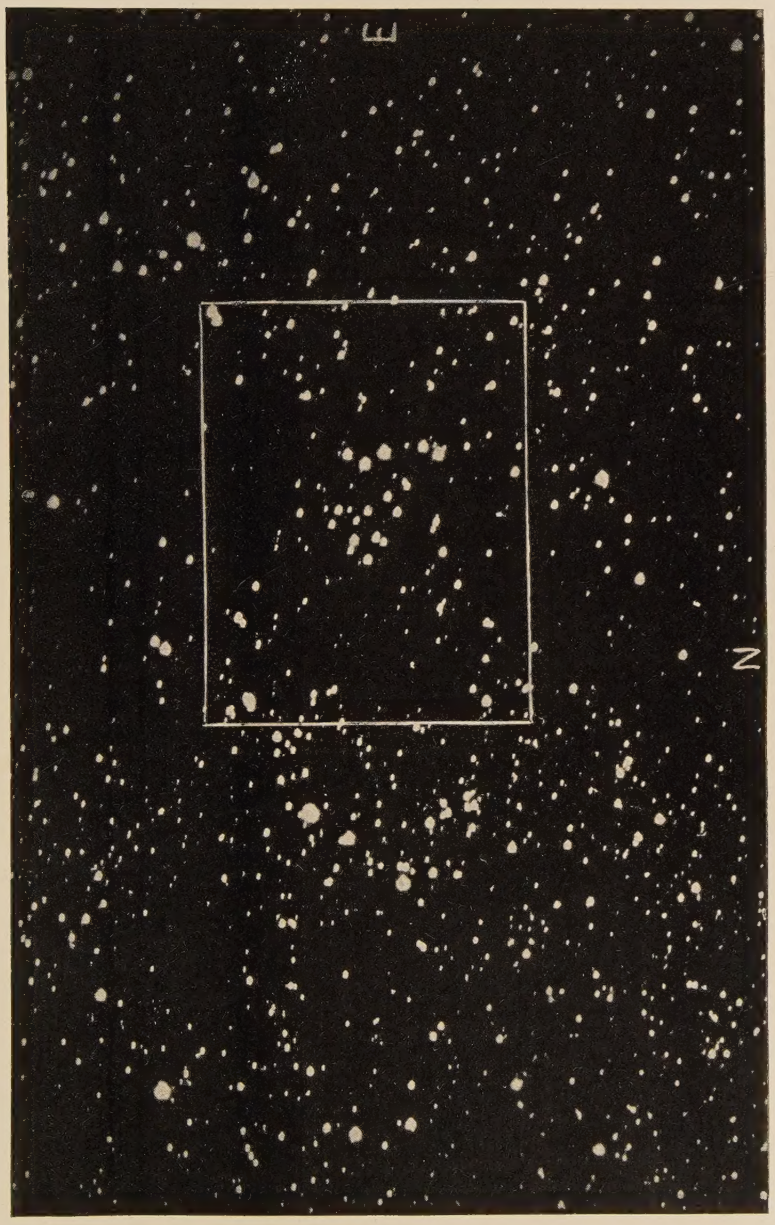
(*a*) With linear terms only.
(*b*) With linear and quadratic terms.
(*c*) By the use of quasi-normal equations obtained by grouping the comparison stars in the East and West halves of the plates and in the North and South halves for x and y respectively.

The motions resulting from the use of each method were plotted separately. They differ only in very minor details. It should be said that the larger motions are all easily visible in the " Blink " comparator.

In order to eliminate the personality of the observer I asked Dr. Frank E. Ross to make a complete set of measures on the same plates. He did this, arranging his operations just as I had done. His measures were reduced by the method (*b*), using the same ten comparison stars. The results are given in parallel columns with mine in the table. Annual motions are given.

The columns in this table are self-explanatory. The first gives the arbitrary number assigned to each star. The unit in the third and fourth columns is the quarter millimetre. The approximate photovisual magnitudes given in the second column were derived as follows. Two plates were selected from the series used for the determination of proper motions and parallaxes in Selected Area No. 41, having the same exposure times as the recent plate on this cluster, and having been obtained under apparently the same conditions of observing. The average of the diameters of the stellar images on the two plates was plotted against the photovisual magnitude as derived by Parkhurst. The dispersion of the individual magnitudes about a smooth curve drawn through them is quite small. The magnitudes given in the tables were simply read from this curve with diameters of images on plate 6744 as argument. For the present they are satisfactory, although they may require a correction for zero-point.

* *Publication of the Yerkes Observatory*, vol. iv., part iv., 13.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Annual Motions in N.G.C. 225.

No. on Plate.	Approx Photo. Vis. Mag.	x.	y.	Motion in x. Lee.	Motion in x. Ross.	Mean.	Motion in y Lee.	Motion in y Ross.	Mean.	D.M. No.
1*	11·5	154	305	·000	+·001	·000	·000	−·001	·000	
2	11·2	165	351	+·014	+·020	+·017	−·009	−·003	−·006	
3	11·2	259	181	+·003	+·002	+·002	−·002	−·004	−·003	
5*	11·2	392	173	−·001	−·002	−·002	·000	+·001	·000	
6	11·0	360	282	+·019	+·016	+·018	−·005	−·007	−·006	°
8	9·3	147	688	−·018	−·013	−·016	−·018	−·019	−·018	+61 147
9	11·3	173	657	−·018	−·012	−·015	−·006	−·003	−·004	
10	9·4	176	774	−·021	−·021	−·021	−·012	−·016	−·014	61 148
11*	12·3	189	757	·000	·000	·000	−·001	−·001	−·001	
12	11·5	240	683	−·017	−·019	−·018	−·005	−·002	−·004	
13	11·1	268	790	−·034	−·038	−·036	−·007	−·007	−·007	
14	10·8	321	684	−·012	−·013	−·012	−·013	−·014	−·014	
15	11·3	404	619	+·016	·000	+·008	+·002	−·007	−·002	
16	11·5	404	618	+·003	+·013	+·008	−·013	+·006	−·004	
17	10·7	352	581	−·020	−·022	−·021	−·011	−·005	−·008	
18	11·5	475	686	−·014	−·014	−·014	−·003	+·005	+·001	
19	10·8	543	568	+·012	+·014	+·013	−·015	−·011	−·013	61 155
20*	12·2	525	561	−·002	−·003	−·002	+·005	+·004	+·004	
21	10·5	475	584	+·002	−·001	·000	−·007	−·001	−·004	61 154
25	9·7	456	419	+·006	+·006	+·006	−·003	+·002	·000	60 84
26	11·4	495	453	·000	−·001	·000	−·001	+·003	+·001	
27*	12·3	509	438	−·004	−·001	−·002	+·004	+·005	+·004	60 86
28	10·8	504	435	+·005	−·001	+·002	−·001	+·002	·000	60 88
29	9·6	475	380	+·006	+·003	+·004	−·004	−·003	−·004	
30	9·9	498	387	−·001	−·001	−·001	−·005	+·001	−·002	60 87
31	10·7	556	266	−·016	−·019	−·018	−·009	−·009	−·009	
32	10·6	532	338	+·044	+·037	+·040	−·002	−·003	−·002	
33	9·8	565	352	+·028	+·024	+·026	−·030	−·031	−·030	60 90
34*	11·8	565	376	+·009	+·008	+·008	−·002	−·002	−·002	
35	10·8	541	392	−·013	−·017	−·015	−·004	−·005	−·004	60 89
36	10·8	564	416	+·002	·000	+·001	−·004	−·001	−·002	60 91
37	10·2	563	482	−·003	−·002	−·002	·000	−·003	−·002	61 157
38	10·4	597	460	+·005	+·003	+·004	+·001	+·001	+·001	61 158
39	11·5	620	502	−·011	−·010	−·010	−·001	+·001	·000	
40*	12·7	630	496	−·002	−·003	−·002	−·006	−·007	−·006	
41	9·6	668	408	−·001	−·002	−·002	+·002	+·001	+·002	60 94

An asterisk in Column 1 indicates a comparison star.

Annual Motions in N.G.C. 225.

No. on Plate.	Approx. Photo. Vis. Mag.	x.	y.	Motion in x. Lee.	Motion in x. Ross.	Mean.	Motion in y. Lee.	Motion in y. Ross.	Mean.	D.M. No.
										°
42	10·0	688	369	−·001	−·005	−·003	+·002	+·001	+·002	60 95
43	9·0	695	450	−·006	−·004	−·005	+·004	+·007	+·006	61 163
44	9·8	709	536	−·017	−·016	−·016	−·001	+·003	+·001	61 164
45	9·6	693	570	−·012	−·009	−·010	+·002	+·006	+·004	61 162
46	11·4	711	633	−·010	−·010	−·010	+·002	+·003	+·002	
47	10·1	657	740	−·052	−·050	−·051	−·002	+·002	·000	
48*	11·8	714	748	+·001	+·002	+·002	·000	·000	·000	
49	12·2	737	681	−·010	−·014	−·012	+·007	+·014	+·010	
50	12·8	767	624	−·010	−·005	−·008	+·007	+·007	+·007	
52	11·1	849	686	+·004	+·004	+·004	+·014	+·017	+·016	
55	11·4	923	568	+·023	+·027	+·025	−·040	−·038	−·039	
56	11·9	843	552	+·011	+·011	+·011	+·008	+·009	+·008	
58	12·4	809	403	−·022	+·007	−·008	−·005	+·007	+·001	
59	11·1	908	351	−·014	−·014	−·014	+·001	+·004	+·002	
60*	12·2	954	340	+·001	−·001	·000	+·001	+·002	+·002	
61	10·9	817	277	+·001	·000	·000	−·005	−·008	−·006	
62*	12·2	858	258	−·002	·000	−·001	·000	−·001	·000	

The average difference Lee-Ross is ″·0028 in x and ″·0030 in y. The motions illustrated in the figure cannot be ascribed to personal equation of the observer.

The only other way of accounting for these motions as due to error is to attribute them to systematic distortions in these plates. The following circumstances probably preclude this possibility.

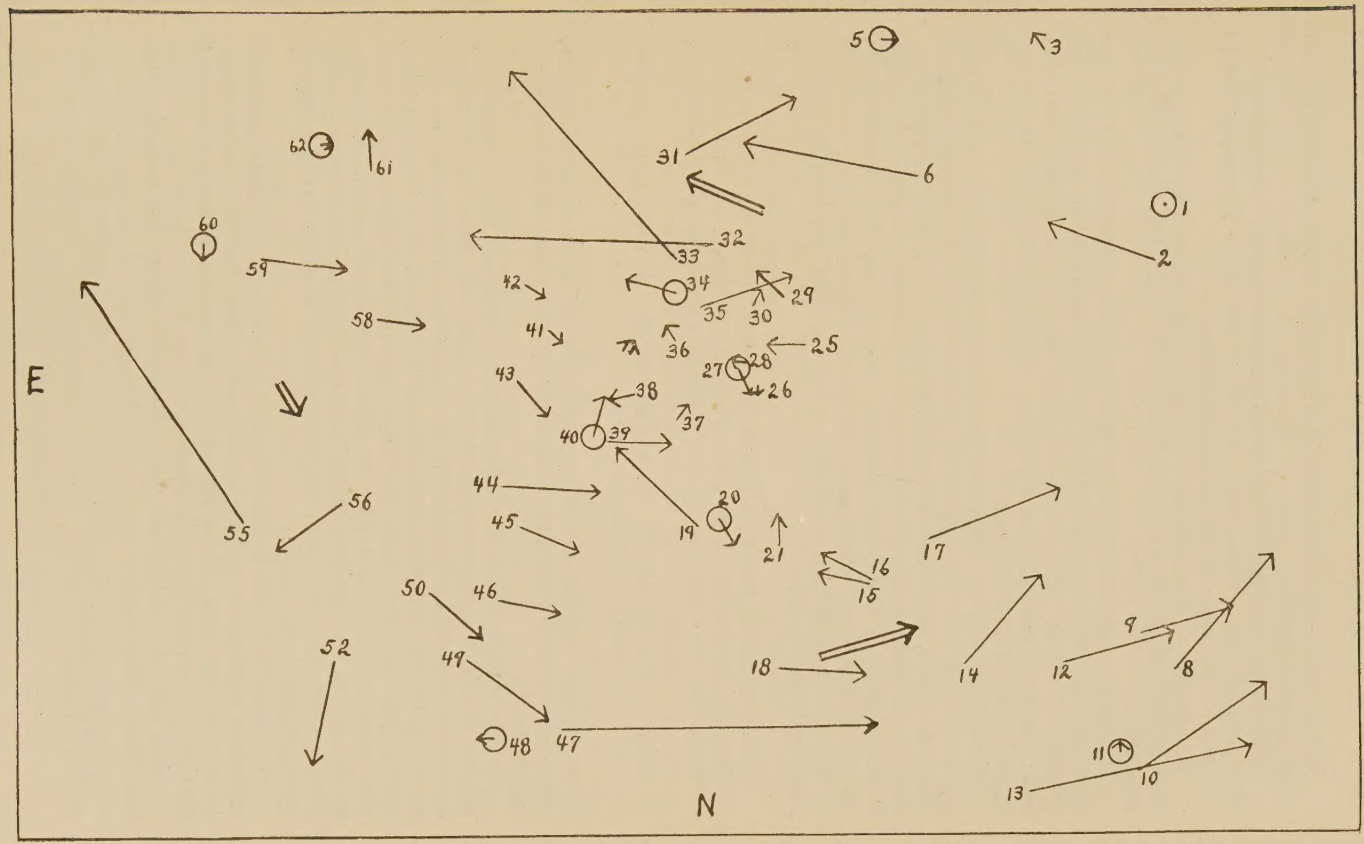
1. The appearance of the films on these plates is normal. The images are sensibly round. They are somewhat smaller and blacker on my plate than on Schlesinger's.

2. With a strictly similar treatment of twenty-four Selected Areas no such a case of systematic motion has appeared. It is true that four plates instead of two were used in the Selected Areas, but on the other hand the intervals of time averaged about eight years, so that the chance of discovering a plate distortion of such a size was nearly three times as great.

3. The observed motions have a direct relation to the geometric configuration of the cluster of stars.

Stars Nos. 15 and 16 form a close double whose images overlap badly on Schlesinger's plate. Measures of them by the two observers are among the most discordant, as was to be expected.

Star No. 47 is a close double of unequal components. There is no noticeable change in position angle of the pear-shaped image in twenty-two years.



Motions in N.G.C. 225 corresponding to a time interval of 13,800 years. Ten stars with circles are comparison stars. Double-shafted arrows are mean motions of groups.

The average magnitude of the 10 comparison stars is 12·02 and of the other 43 stars 10·75.

The average total motion of the comparison stars is ″·0030 referred to their own system. The average motion of the other 43 stars is ″·0149 referred to the same net of comparison stars.

An analysis of the motions with brightness shows that down to the 12th magnitude the stars are well mixed, both in amount and in direction of motion.

Both the geometric figure of the cluster and motions are so unsymmetrical that averages will not give the translational motion of the group as a whole. The strong westward motions along the north side of this field definitely indicate physical connection with the larger configuration shown on the plate.

Examination of the diagram of motions indicates that if stars 33 and 55 be set apart for the moment as probable interlopers racing past on parallel courses, there remain a northern group of 15 stars moving westward, a southern group of 5 stars headed eastward, an eastern group of 6 stars having a northward resultant motion, and the central group essentially stationary with respect to the 10 comparison stars.

The following groups of stars give the resultant motion indicated in x and y respectively :—

Nos. 2, 3, 5, 31, 32 give +″·0118 ; −″·0052.
Nos. 50, 52, 56, 58, 59, 61 give −″·0025 ; +″·0047.
Nos. 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 44, 45, 46, 47, 49 give −″·0157 ; −″·0038.
Nos. 19, 21, 25, 26, 28, 29, 30, 35, 36, 37, 38, 39, 41, 42, 43 give −″·0005 ; −″·0013.

These average motions are shown on the plot as double-shafted arrows, each located conveniently near the centre of the group of stars which it represents.

Removal of the effect of solar motions by correction for the parallactic motion of the comparison stars of 12th magnitude does not, of course, alter the rotational effect shown by the group. Since, also, we have reason to believe that our parallactic tables may be very much in error, especially in the part of the sky which contains this cluster, it does not now seem worth while trying to get its motion in space. Assuming $6^h\ 0^m - 34°$ as the position of the antapex of solar motion the angular distance λ of this point from the cluster is 115° and the position angle ψ by chance the same, 115°.

So far as the writer knows there are no plates of this larger group in existence that have sufficient time and scale factors to determine motions of this size. If by chance such plates are at hand it is urged that they be measured and reduced.

Miss Lela D. Cable has very efficiently made the computations described in this paper.

Yerkes Observatory :
1926 *June* 4.

Remarks on a Paper by Professor R. A. Sampson: The Structure of the Solar Cluster. By Professor H. Kienle and Dr. P. ten Bruggencate.

(*Communicated by the Secretaries.*)

1. In a recent paper * Professor Sampson believes to have found that the Sun is near the centre of a star cluster of remarkable concentration and globular structure. The material he uses consists of 1200 stars with measured trigonometric parallaxes, distributed over all spectral classes. Professor Sampson forms different groups of the stars according to spectral type and mean density. Instead of density, we may also use the mean absolute magnitude of the stars, which is shown by his Schedule I.; the more so as the "mean density" is no primary result of measures, but calculated from Eddington's "mass-luminosity" law.

For each group, consisting only of stars of the same spectral type and nearly equal absolute magnitude, Professor Sampson counts the number (N) of stars within and up to any assigned distance (D). Plotting these numbers as ordinates and the distances as abscissæ, he gets for each group curves of the same general character: parabolas of the third order near the origin, but having an inflexion at a certain distance and finally converging to an asymptotic limit. As Professor Sampson states, the function $N=f(D)$ will always have in practice a finite limit for $D=\infty$, and therefore also a point of inflexion, because "with constant absolute magnitude and increasing distance, the stars would fall in brightness until they passed out of the practical observing list." May the curves, found for each group, be explained by this "effect of distance" or not? Professor Sampson treats this question as follows: the mean absolute magnitude (M) for each group and the distance corresponding to the inflexion (D_i) are known. We can therefore calculate the apparent magnitudes of the members of each group which occur at the distance D_i belonging to it. These apparent magnitudes are functions of the spectral type and the absolute magnitude. For the same spectral type they increase with absolute magnitude. Professor Sampson says: "Now it is certain that a false clustering which in reality was the effect of distance would operate at the same apparent magnitude upon all classes and groups. It is impossible to explain by such means the progressions shown in the table above." Therefore, he concludes, the inflexions and finite limits of the curves must be real. The curves now give the real structure of the Solar Cluster.

2. A result of the statistical works of Seeliger, Schwarzschild, Kapteyn, van Rhijn, and others is that there exists *no remarkable concentration* of stars in the neighbourhood of the Sun. Therefore Professor Sampson's result, if it is real, would be of great importance. But it can easily be shown, at least qualitatively, that his conclusion is based on an incomplete analysis of the "distance effect." It is true that his Table I. "may be regarded as the demonstration that we are not dealing with mere visual extinction," but in the case of trigonometric parallaxes the "distance effect" consists not only of "visual extinction." This

* *Monthly Notices*, **86**, No. 6, p. 390.

would be the case if, *for a programme of trigonometric parallaxes, the stars were selected according to their apparent magnitude only, without regard to their proper motion.* If the stars were selected only according to their apparent magnitude, then it is certainly impossible to explain the progressions in Table I. Then, and only then, we must expect that, for each group, the same apparent magnitude belongs to the distance D_i, giving the limit of completeness of the parallax catalogue. The selection of the stars according to proper motion being different for each spectral class (S) and each absolute magnitude (M), we need not be astonished that the above-mentioned apparent magnitudes show a progression with both parameters M and S. The Schedule I. of Professor Sampson's paper does not permit a quantitative investigation of the distance effect. All that we can do *is to show that the variation of* D_i *with* M *and* S *may be qualitatively explained by the selection of the stars according to apparent magnitude and proper motion.*

3. Three years ago Dr. Hess, at the suggestion of one of the writers, showed,* by discussing the Mt. Wilson spectroscopic parallaxes, how the *systematic* errors entering into statistical investigations on the density and luminosity laws of the stars in the Sun's neighbourhood by the selection principles, may be converted into *accidental* errors. The method, briefly stated, is as follows: The probability ($W_{m,\mu}$) that a star of apparent magnitude between m and $m+dm$, and proper motion between μ and $\mu+d\mu$, is contained in the parallax catalogue used, will be equal to the number of stars of this kind in the catalogue ($n_{m,\mu}$), divided by the number of all stars of this kind ($N_{m,\mu}$), thus

$$W_{m,\mu}=\frac{n_{m,\mu}}{N_{m,\mu}}.$$

n and N are known quantities. The first number is easily obtained by counting the stars of the parallax catalogue, the second may be taken from the tables of Kapteyn and van Rhijn in Groningen Publ. 30. If we now assign to each star of the catalogue of apparent magnitude m and proper motion μ the "weight"

$$p_{m,\mu}=\frac{1}{W_{m,\mu}}=\frac{N_{m,\mu}}{n_{m,\mu}},$$

then the systematic errors are converted into accidental errors, produced by the different partition of the parallaxes among the stars n and N. If, after we have corrected the counted star-numbers by these weights, there still remains an inflexion and finite limit in the curves $N=f(D)$, then, and only then, may we conclude that there exists a real clustering in the neighbourhood of the Sun. It is not possible for us to derive for the stars used by Professor Sampson the "weights" $p_{m,\mu}$, because he does not give in his paper apparent magnitude and proper motion of each star used.

That the "distance effect" really enters into Professor Sampson's investigations is evident, since he uses *all* measured trigonometric parallaxes. If he used a "Durchmusterung," *i.e.* the parallaxes of *all*

* *Astron. Nachr.*, **220**, 65.

stars down to a certain apparent magnitude, then part of the effect would be eliminated. For each absolute magnitude the distance, up to which all stars are contained in the material, could be stated. Since he does not try to correct his results for the distance effect at all, these results must be incorrect. To what amount such errors may rise is shown in the above-cited paper of Dr. Hess.

4. If we make the assumption that up to a distance of 60 parsecs the density of the stars of each group is constant, all curves

$$\left(\frac{N^*}{N_u^*}\right)_{M,\,S} = f^*_{M,\,S}(D)$$

must be identical in the interval from D = 0 to D = 60 parsecs, where N* means the numbers N corrected for selection. N_u^* is the limiting value of N for $D \to \infty$. The indices M, S show that the quotient depends on absolute magnitude and spectral class. The curves

$$\left(\frac{N}{N_u}\right)_{M,\,S} \quad f_{M,\,S}(D)$$

of Professor Sampson's paper are not identical because they are not corrected for the complete distance effect. To correct them, that is, to make all curves coincide with any one which may be arbitrarily chosen, we must multiply the numbers

$$\left(\frac{N}{N_u}\right)_{M,\,S}$$

by a relative distance factor $p_{M,\,S}(D)$, which depends on the distance, absolute magnitude, and spectral class; for each group M and S are constant. Thus we may put as first approximation

$$M = m + 5 + 5s \log \mu,$$

where s is constant for groups of the same spectral class. This shows that the distance factor

$$p_{M,\,S}(D)$$

will depend, if we consider only groups of the same spectral class, on distance, apparent magnitude, and proper motion. Let us now consider the stars of each such group, the distances of which lie between D and D+dD. Then the values of the factors $p_{M,\,S}(D)$ belonging to this distance interval will now only depend on apparent magnitude and proper motion. Let us take for example the class of K-stars and the interval between 30 and 40 parsecs, which corresponds to the Zone IV. of Hess's paper.* If we suppose that the parallax catalogue is complete for all K-stars of apparent magnitude greater than $4^{m}\cdot0$, the K-stars absolutely brighter than $+1^{m}\cdot0$ which lie between 30 and 40 parsecs must be completely known. That is, the curves

$$\left(\frac{N}{N_u}\right)_{M,\,K} = f_{M,\,K}(D)$$

* *Loc. cit.*, p. 66.

must be nearly identical for $M \leqq +1^{m}\cdot0$ and $30<D<40$; it follows that

$$p_{M,\,K}(35) : p_{M_0,\,K}(35) \sim 1,$$

if M and M_0 are smaller than $+1^{m}\cdot0$. The list of stars at a mean distance of 35 parsecs, belonging to groups with $M \geqq +1^{m}\cdot0$, becomes more and more incomplete on account of decreasing apparent brightness of the stars. But, on the other hand, μ will increase with decreasing absolute brightness and therefore outweigh, at least for the Dwarf K-stars, to some degree the incompleteness of the counted star numbers. Thus we may expect, merely qualitatively, that the quotient

$$p_{M,\,K}(35) : p_{M_0,\,K}(35) \quad (M_0 \leqq +1^{m}\cdot0)$$

will first increase with increasing M from 1·0 to a maximum value, to which belong stars of relatively small apparent magnitude and small proper motion. The corresponding value of M will lie between the values of M belonging to the characteristic Giants and Dwarfs, say, between the absolute magnitudes $3^{m}\cdot0$ and $5^{m}\cdot0$. Then the quotient will decrease with further increasing M, because stars of greater proper motion now enter into the parallax catalogue. The following table contains the values of the relative distance factors $p_{M,\,K}(35)$, relative to the curve belonging to the group of mean absolute magnitude $-0^{m}\cdot4$:—

M.	$p_{M,\,K}(35)$.	M.	$p_{M,\,K}(35)$.
(−2·4	0·5)	+3·0	2·2
−1·4	0·7	+3·8	2·4
−0·4	1·0	+5·1	2·1
+0·8	1·6	+5·9	1·7
+1·8	2·0	+7·0	1·7

The computed values show the expected progression. The general character of progression is the same as that of Hess's weights in Table XXII. of his paper. This shows, at least qualitatively, that it is very improbable that Professor Sampson's effect is real.

5. It is possible to attack the problem in another way, which also shows qualitatively the improbability of Professor Sampson's conclusions. He finds that it is possible to put for each group

$$N = \frac{N_u k^3}{2} \int_0^D e^{-kD} \cdot D^2 dD,$$

where k and N_u are constants characteristic for each group, and e^{-kD} gives the " real density law " of the group. Now let δ be the *constant* star density up to distances of the order of 100 parsecs. Let W(D) be the probability that a star of a certain group at a certain distance is contained in the parallax catalogue. Then the observed number of stars within and up to any distance D will be

$$N = 4\pi\delta \int_0^D W(D) \cdot D^2 dD.$$

Equating the integrals, we get

$$W(D) = \frac{N_u k^3}{8\pi\delta} \cdot e^{-kD}.$$

For small values of D, Professor Sampson's formula gives

$$N=\frac{N_u k^3}{6}\,.\,D^3,$$

showing that for small distances the material must be complete. From this we get

$$\frac{N_u k^3}{6}=\frac{4\pi}{3}\delta,$$

or

$$\frac{N_u k^3}{8\pi\delta}=1.$$

Therefore

$$W(D)=e^{-kD}, \text{ if } D>D' \quad \text{and} \quad W(D)=1, \text{ if } D\leqq D',$$

where D′ indicates the limit of completeness. On the other hand, we shall have

$$W\backsim\frac{n_{m,\,\mu}}{N_{m,\,\mu}}.$$

Thus, omitting for brevity the indices m and μ,

$$\frac{n}{N}\backsim e^{-kD}.$$

Consider now a group of Giants and a group of Dwarfs *of the same spectral class*. Then

$$\left(\frac{n}{N}\right)_g:\left(\frac{n}{N}\right)_d=e^{-(k_g-k_d)D}.$$

Up to a certain value of D′ we shall have

$$\left(\frac{n}{N}\right)_g=1.$$

But for the same value D′ the material concerning Dwarf stars is surely incomplete ; that is to say,

$$\left(\frac{n}{N}\right)_d<1.$$

Therefore

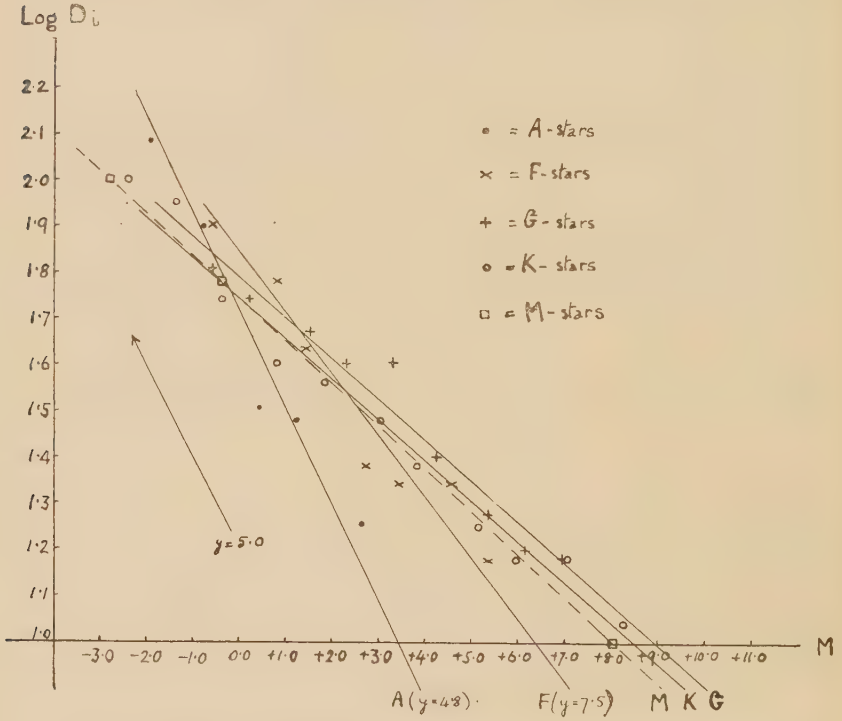
$$k_g-k_d$$

must be negative, and the numerical value increases with increasing numerical values of M_g-M_d. This is shown in the following table :—

A.		F.		G.		K.	
M_g-M_d.	k_g-k_d.	M_g-M_d.	k_g-k_d.	M_g-M_d.	k_g-k_d.	M_g-M_d.	k_g-k_d.
−4·5	−0·084	−5·9	−0·108	−7·5	−0·102	−10·6	−0·162
−2·0	042	−3·7	058	−5·8	089	− 8·4	111
−1·2	037	−2·0	044	−3·8	062	− 6·3	097
−0·8	−0·004	−1·3	036	−1·8	030	− 4·3	061
		−0·7	−0·008	−1·0	000	− 2·0	027
				−0·8	−0·030	− 1·2	011
						− 0·8	−0·016

It is remarkable that the progression of $k_g - k_d$ or $W_g : W_d$ with $M_g - M_d$ is much smaller for the K-stars than for the A-stars. This is easily explained by the well-known phenomenon that K-Dwarfs have greater proper motions than A-Dwarfs. The parallax catalogues are relatively more complete as regards the former than the latter.

6. Finally, we will plot the mean absolute magnitude (M) of each group of stars against D_i, the distances of the inflexion points. If the



" distance effect " consists of merely visual extinction, all points in the figure must lie on a straight line

$$M + 5 \log D_i = \text{const.}$$

The constant is given by the apparent magnitude (m), which indicates the beginning of the incompleteness of the material ; thus

$$\text{const} = m + 5.$$

But we know that the " distance effect " does not only consist of mere visual extinction. The difference between mere visual extinction and the true distance effect will be the larger the later the spectral type. For the A-stars we may expect a good representation of the observations

by the formula $M+5\log D_i=m+5$, but not for the K-stars. We can qualitatively say in what sense the discrepancy between the formula and the observation for later spectral types lies. *The later the spectral type the more stars there will occur in our parallax catalogues, selected upon their larger proper motions, which in the case of mere visual extinction would pass out of the practical observing list.* Thus the straight line $M+y\log D_i=x$ is the more parallel to the axis of M the later the spectral type. $\frac{-1}{y}$ is the tangent of the angle between the straight line and the axis of M. Thus the later the spectral type, the larger y must be; it must start at the A-stars from the value $y_A=5$. By the method of mean squares the straight lines $M+y\log D_i=x$ were found for each spectral type separately, with the following results :—

A-stars : $M+4{\cdot}8\log D_i=+8{\cdot}2$
F-stars : $M+7{\cdot}5\log D_i=+13{\cdot}8$
G-stars : $M+11{\cdot}3\log D_i=+20{\cdot}2$
K-stars : $M+11{\cdot}4\log D_i=+19{\cdot}8$
M-stars : $M+10{\cdot}6\log D_i=+18{\cdot}4$
Mean G-M-stars : $M+11{\cdot}3\log D_i=+19{\cdot}9$

From the equation of the A-stars we may conclude that the parallax catalogue of Professor Sampson will be complete (for A-stars only) to the apparent magnitude

$$m=8{\cdot}2-5=3{\cdot}2.$$

7. Looking at the results of the above-developed qualitative methods of estimating the *complete* distance effect, we may conclude that the speculations of Professor Sampson on the structure of a Solar Cluster cannot be true, but are caused by an insufficient analysis of the problem of selection principles in practical astronomy. Professor Sampson must first eliminate the distance effect according to the method of weighting the star-numbers shown by Hess. Then, perhaps, absolutely no clustering will remain.

Göttingen, Universitäts-Sternwarte :
1926 *June* 18.

Occultations of Stars by the Moon, observed at Engelhardt Observatory, Kasan, during the Years 1914–1924.

Nos. 1–88 were reduced by A. A. Jakovkin, and Nos. 89–227 by K. K. Dubrovsky.

No.	Date.	Greenwich Mean Time. h m s	Star.	Phenomenon.	Instrument and Power.	Observer.	Remarks.
1	1914 June 7	6 41 56·5	Hedrick 1067	R	R 143	Bn	
2	Oct. 10	7 3 58·6	,, 410	D	F 108	G	
3	10	8 1 33·1	A.G. Cambr. 3510	D	F 108	G	
4	Nov. 3	2 16 26·4	Hedrick 177	D	F 108	G	
5	3	2 16 28·7	,, 177	D	R 143	Bn	
6	3	2 59 19·7	,, 177	R	R 143	Bn	
7	1915 Apr. 23	8 38 34·8	,, 636	D	F 108	G	
8	23	8 38 34·9	,, 636	D	R 143	Bn	
9	23	8 38 34·4	,, 636	D	H 132	J	
10	1916 Apr. 14	5 18 35·9	Alb. 4139	D	R 143	H	
11	14	6 18 13·1	Hedrick 713	D	R 143	H	
12	15	6 24 5·5	,, 757	D	R 143	H	
13	Aug. 15	9 5 23·2	,, 1582	D	F 108	G	
14	15	9 5 24·5	,, 1582	D	R 143	H	
15	15	9 59 23·3	,, 1582	R	F 108	G	
16	Sept. 16	12 6 15·3	,, 225	D	F 108	G	
17	16	12 6 15·3	,, 225	D	R 143	H	
18	Nov. 9	8 36 57·9	,, 177	D	R 143	H	
19	10	5 9 33·5	Berl. B. 1207	D	A 110	J	
20	10	5 9 34·0	,, 1207	D	R 143	H	
21	10	6 2 0·1	Hedrick 226	D	R 143	H	
22	10	6 13 57·0	Berl. B. 1207	R	R 143	H	
23	10	7 4 0·1	Hedrick 226	R	R 143	H	
24	1917 Jan. 26	2 42 17·3	,, 1564	D	R 143	H	
25	26	2 42 17·4	,, 1564	D	F 108	G	
26	26	2 42 17·9	,, 1564	D	K 60	T	
27	26	2 42 17·3	,, 1564	D	H 132	J	
28	26	2 42 17·2	,, 1564	D	A 110	Z	
29	29	4 50 41·9	,, 124	D	R 143	H	
30	29	4 50 42·0	,, 124	D	F 108	G	
31	29	4 50 41·9	,, 124	D	K 60	T	
32	29	4 50 41·9	,, 124	D	H 132	J	
33	29	4 50 41·7	,, 124	D	A 110	Z	

No.	Date.	Greenwich Mean Time. h m s	Star.	Phenomenon.	Instrument and Power.	Observer.	Remarks.
34	[1917 Jan. 30	3 16 52·0	Hedrick 177	D	F 108	G	
35	30	3 16 52·6	,, 177	D	K 60	T	
36	30	3 16 52·3	,, 177	D	H 132	J	
37	30	3 16 52·1	,, 177	D	A 110	Z	
38	30	4 33 56·5	,, 177	R	F 108	G	
39	30	4 34 4·1	,, 177	R	A 110	Z	
40	31	9 13 11·6	,, 245	D	F 108	G	
41	31	9 13 11·5	,, 245	D	K 60	T	
42	31	9 13 11·8	,, 245	D	H 132	J	
43	31	9 13 11·6	,, 245	D	A 110	Z	
44	Feb. 4	3 20 58·8	,, 511	D	F 108	G	
45	4	3 20 58·9	,, 511	D	A 110	Z	
46	4	3 53 44·6	,, 513	D	R 143	H	
47	4	3 53 44·7	,, 513	D	F 108	G	
48	4	3 53 44·7	,, 513	D	K 60	J	
49	4	3 53 44·4	,, 513	D	A 110	Z	
50	26	4 16 40·7	,, 159	D	R 143	H	
51	26	4 16 40·7	,, 159	D	F 108	G	
52	26	4 16 40·9	,, 159	D	K 60	T	
53	26	4 16 40·8	,, 159	D	H 132	J	
54	26	4 16 40·5	,, 159	D	A 110	Z	
55	26	4 38 23·8	Berl. A 733	D	K 60	J	
56	26	4 38 23·4	,, 733	D	A 110	Z	
57	Mar. 1	4 38 18·4	Hedrick 372	D	A 110	Z	
58	Apr. 25	6 47 51·8	Berl. B 1982	D	K 60	T	
59	25	6 47 51·9	,, 1982	D	F 108	Z	
60	May 30	6 52 14·7	Hedrick 768	D	F 108	G	
61	30	6 52 14·5	,, 768	D	R 143	H	
62	30	6 52 14·3	,, 768	D	H 132	J	
63	30	6 52 14·3	,, 768	D	A 110	Z	
64	Aug. 2	5 55 59·3	,, 1354	D	R 143	J	± 1s.
65	2	5 55 48·3	,, 1354	D	A 110	Z	
66	2	6 51 39·0	,, 1358	D	F 108	G	
67	2	6 51 30·3	,, 1358	D	K 60	T	
68	2	6 51 38·0	,, 1358	D	R 143	J	
69	2	6 51 34·3	,, 1358	D	A 110	Z	
70	Sept. 29	6 12 12·9	,, 1562	D	F 108	G	
71	29	6 12 13·1	,, 1562	D	K 60	J	
72	29	6 12 12·9	,, 1562	D	R 143	Z	

No.	Date.	Greenwich Mean Time. h m s	Star.	Phenomenon.	Instrument and Power.	Observer.	Remarks.
73	1917 Sept. 29	8 36 51·8	Hedrick 1564	D	R 143	Z	
74	29	8 54 34·5	,, 1563	D	R 143	Z	
75	29	9 20 44·7	,, 1563	R	R 143	Z	
76	Oct. 26	4 34 48·4	,, 1532	D	F 108	Dr	
77	26	4 34 47·8	,, 1532	D	A 110	T	
78	26	4 34 48·1	,, 1532	D	R 143	Z	
79	26	4 34 48·3	,, 1532	D	H 132	J	
80	Nov. 27	3 30 47·3	,, 190	D	F 108	G	
81	27	3 30 47·0	,, 190	D	A 110	T	
82	27	3 30 47·2	,, 190	D	R 143	Z	
83	27	3 30 47·2	,, 190	D	H 132	J	
84	27	6 23 33·0	,, 194	D	F 108	G	
85	27	6 23 33·2	,, 194	D	A 110	T	
86	27	6 23 32·9	,, 194	D	R 143	Z	
87	Dec. 28	5 30 29·8	,, 473	D	F 108	G	
88	28	5 30 28·9	,, 473	D	A 110	Z	
89	1918 Feb. 18	10 7 4·9	,, 314	D	R 143	Dr	
90	20	6 41 52·9	,, 442	D	R 143	Dr	
91	20	7 43 6·9	,, 442	R	R 143	Dr	
92	Mar. 21	10 23 37·4	,, 561	D	R 143	Dr	
93	Apr. 22	6 53 18·7	,, 752	D	R 143	Dr	
94	Oct. 15	7 47 43·4	,, 1452	D	R 143	Dr	
95	16	6 58 1·5	,, 1510	D	F 108	Dr	
96	16	6 58 1·8	,, 1510	D	R 143	M	
97	16	7 24 3·7	,, 1510	R	F 108	Dr	
98	16	8 35 51·8	,, 1514	D	F 108	Dr	
99	16	8 35 52·2	,, 1514	D	R 143	M	
100	16	9 38 2·5	,, 1514	R	R 143	M	
101	Dec. 21	7 36 12·6	,, 640	R	F 108	M	
102	21	7 36 12·8	,, 640	R	R 143	Dr	
103	1919 Jan. 20	7 21 8·4	,, 752	R	R 143	Dr	$+20^s$?
104	Apr. 9	3 45 33·9	,, 625	D	R 143	M	
105	9	4 51 18·6	,, 625	R	R 143	M	
106	May 5	8 49 56·9	,, 560	D	R 143	Dr	Just above horizon
107	July 11	7 51 57·2	,, 1185	D	R 143	Dr	
108	11	7 51 59·7	,, 1185	D	Z 89	Db	
109	11	8 7 38·8	,, 1185	R	R 143	Dr	Uncertain : sta faint.
110	12	9 25 26·5	,, 1272	D	R 143	Dr	Moon almost full clouds.
111	16	10 55 53·4	,, 1510	D	R 308	Dr	
112	16	10 55 53·9	,, 1510	D	A 110	J	
113	Aug. 8	5 54 20·1	,, 1231	D	A 110	Db	

No.	Date.	Greenwich Mean Time.	Star.	Phenomenon.	Instrument and Power.	Observer.	Remarks.
		h m s					
114	1919 Sept. 16	8 37 38·8	Hedrick 377	R	Z 89	Db	
115	Oct. 7	9 54 34·9	,, 1562	D	R 143	Dr	Clouds.
116	1920 Mar. 25	4 39 33·6	,, 329	D	R 143	Dr	
117	25	4 39 33·5	,, 329	D	A 110	P	
118	25	5 40 23·8	,, 329	R	R 143	Dr	
119	Apr. 3	7 24 46·0	,, 838	D	R 143	Dr	
120	3	8 32 52·5	,, 838	R	R 143	Dr	
121	30	8 3 56·7	,, 830	D	R 143	Dr	
122	30	8 3 56·4	,, 830	D	H 132	J	
123	May 24	7 14 31·4	,, 682	D	Z 133	Dr	
124	Oct. 20	2 17 36·9	,, 1350	R	Z 89	Dr	
125	Nov. 22	6 42 7·7	,, 57	D	R 308	Dr	
126	22	7 49 57·1	,, 57	R	R 308	Dr	
127	Dec. 18	6 53 23·9	,, 1592	D	H 132	J	
128	1921 Apr. 14	8 32 16·7	,, 497	D	R 143	Dr	
129	14	8 32 16·8	,, 497	D	F 108	G	
130	1923 Jan. 27	3 59 3·5	,, 297	D	R 143	Dr	
131	27	4 44 26·9	,, 297	R	R 143	Dr	
132	July 30	10 34 0·7	,, 1537	D	R 143	Dk	
133	Sept. 1	9 27 37·0	,, 197	D	R 143	Dk	Through clouds.
134	2	11 26 49·3	,, 261	D	R 143	Dk	Clouds.
135	Dec. 15	2 52 48·6	,, 1602	D	R 143	Dr	
136	15	2 52 48·2	,, 1602	D	A 110	J	
137	15	2 49 9·9	,, 1598	D	A 110	J	
138	15	3 13 55·7	,, 1602	R	R 143	Dr	
139	1924 Jan. 17	3 32 19·7	,, 296	D	A 110	J	
140	17	3 33 58·2	,, 297	D	A 110	J	
141	17	3 33 57·4	,, 297	D	R 143	Dk	
142	17	4 6 56·7	,, 299	D	A 110	J	Not instantaneous ($0^s·3$).
143	17	4 6 56·6	,, 299	D	R 143	Dk	
144	17	4 59 32·0	,, 302	D	A 110	J	
145	17	4 59 31·1	,, 302	D	R 143	Dk	
146	17	5 2 10·3	,, 305	D	R 143	Dk	
147	17	8 44 17·2	,, 313	D	Z 64	G	Good.
148	17	8 44 17·3	,, 313	D	A 110	J	
149	17	8 44 16·7	,, 313	D	R 143	Dk	
150	17	9 10 45·6	,, 313	R	F 108	G	Good.
151	17	9 10 44·3	,, 313	R	A 110	J	
152	17	9 10 44·9	,, 313	R	R 143	Dk	
153	Feb. 13	6 37 26·2	,, 261	D	R 143	Dr	
154	13	6 37 25·4	,, 261	D	H 132	J	
155	13	8 59 8·3	,, 266	D	R 143	Dr	

No.	Date.	Greenwich Mean Time. h m s	Star.	Phenomenon.	Instrument and Power.	Observer.	Remarks.
156	1924 Feb. 20	3 24 16·1	$\left\{\begin{matrix}10^h\ 11^m\cdot2\ ; \\ +10°\ 20'\end{matrix}\right\}$*	D	R 143	Dr	
157	20	3 33 0·3	Lpz. I. 3981	D	R 143	Dr	
158	20	3 41 49·7	$\left\{\begin{matrix}10^h\ 12^m\cdot1\ ; \\ +10°\ 33'\end{matrix}\right\}$*	D	R 143	Dr	
159	20	4 21 58·8	$\left\{\begin{matrix}10^h\ 13^m\cdot3\ ; \\ +10°\ 17'\end{matrix}\right\}$*	D	R 143	Dr	
160	20	4 25 6·6	Lpz. I. 3991	D	R 143	Dr	
161	20	4 28 51·0	$\left\{\begin{matrix}10^h\ 13^m\cdot4\ ; \\ +10°\ 35'\end{matrix}\right\}$*	D	R 143	Dr	
162	20	4 37 16·1	$\left\{\begin{matrix}10^h\ 13^m\cdot4\ ; \\ +10°\ 19'\end{matrix}\right\}$*	D	R 143	Dr	
163	20	4 41 55·2	$\left\{\begin{matrix}10^h\ 14^m\cdot1\ ; \\ +10°\ 14'\end{matrix}\right\}$*	D	R 143	Dr	
164	20	4 41 55·0	$\left\{\begin{matrix}10^h\ 14^m\cdot1\ ; \\ +10°\ 14'\end{matrix}\right\}$*	D	Z 64	J	
165	20	4 46 10·1	Lpz. I. 3994	D	R 143	Dr	
166	Mar. 15	6 39 52·6	Berl. A 2776	D	R 308	Dr	
167	15	6 45 37·7	,, 2779	D	R 308	Dr	
168	Apr. 7	4 36 43·5	Hedrick 210	D	R 308	Dr	
169	9	5 3 51·2	Berl. A 1456	D	R 308	Dr	
170	10	4 49 27·1	,, 1920	D	A 110	Dr	
171	10	4 49 26·0	,, 1920	D	R 143	Dk	
172	11	5 50 50·4	,, 2529	D	A 183	Dk	
173	11	6 55 49·4	,, 2557	D	R 308	Dr	
174	11	6 59 19·8	,, 2544	D	R 308	Dr	
175	11	7 27 38·3	,, 2566	D	R 308	Dr	
176	12	4 45 32·9	,, 3053	D	R 143	Dk	
177	12	9 32 20·9	,, 3138	D	R 143	Dk	
178	14	4 55 13·9	Hedrick 646	D	R 143	Dk	
179	14	5 15 14·4	Lpz. I. 3800	D	R 143	Dk	
180	14	6 56 30·7	,, 3816	D	R 143	Dk	
181	14	6 56 31·7	,, 3816	D	A 183	Dr	
182	14	7 52 27·0	,, 3827	D	R 143	Dk	Through clouds.
183	14	9 44 12·8	,, 3848	D	R 143	Dk	
184	14	9 44 14·2	,, 3848	D	A 183	Dr	(?).
185	14	11 1 32·5	Hedrick 658	D	R 143	Dk	Through clouds.
186	15	9 1 30·5	,, 702	D	R 308	Dr	
187	15	9 1 30·3	,, 702	D	A 183	Dk	
188	15	9 1 30·1	,, 702	D	H 132	J	

* 1900·0.

No.	Date.	Greenwich Mean Time. h m s	Star.	Phenomenon.	Instrument and Power.	Observer.	Remarks.
189	1924 May 9	7 10 57·1	Hedrick 525	D	R 143	Dr	
190	9	7 10 57·3	,, 525	D	Z 89	Dk	
191	11	8 35 54·2	Lpz. I. 3733	D	R 143	Dr	
192	Aug. 8	6 28 23·6	Hedrick 982	D	R 143	Dr	
193	8	6 28 24·1	,, 982	D	Z 89	J	
194	21	7 56 29·5	,, 203	R	Z 64	Dr	
195	21	7 56 29·7	,, 203	R	H 132	J	
196	22	10 46 26·7	,, 287	D	R 143	Dk	
197	22	10 50 54·6	,, 289	D	R 143	Dr	
198	22	10 50 53·7	,, 289	D	H 132	J	Star just visible, second uncertain.
199	22	10 50 49·5	,, 289	D	F 108	Br	Too early.
200	22	11 26 59·7	,, 287	R	R 143	Dr	Too late.
201	22	11 44 9·2	,, 289	R	R 143	Dr	
202	22	11 44 8·2	,, 289	R	F 108	Br	
203	22	11 44 8·4	,, 289	R	Rs 58	Dk	
204	22	12 8 51·0	,, 296	D	R 143	Dk	
205	22	12 8 48·8	,, 296	D	Rs 58	Dr	Too early.
206	22	12 8 50·7	,, 296	D	H 132	J	Sky nebulous, clouds.
207	22	12 8 50·2	,, 296	D	F 108	Br	Clouds.
208	22	12 9 26·8	,, 297	D	R 143	Dk	
209	22	12 9 25·7	,, 297	D	Rs 58	Dr	
210	22	12 9 29·0	,, 297	D	H 132	J	Through clouds.
211	22	12 9 26·4	,, 297	D	F 108	Br	Clouds.
212	22	13 21 51·0	,, 297	R	R 143	Dk	
213	22	13 23 58·9	,, 296	R	R 143	Dk	
214	22	13 32 9·6	,, 302	D	R 143	Dk	
215	Sept. 7	4 45 21·1	,, 1187	D	R 308	Dr	
216	7	4 45 20·3	,, 1187	D	Z 64	J	
217	Oct. 16	4 56 31·8	,, 302	D	R 143	Dk	
218	16	7 40 50·0	,, 313	D	R 143	Dk	
219	16	8 50 48·6	,, 313	R	R 143	Dk	
220	16	8 50 44·7	,, 313	R	F 108	G	Seconds erroneously taken.
221	Nov. 10	9 1 26·5	,, 164	D	R 143	Dk	
222	10	9 1 26·9	,, 164	D	A 183	Dr	
223	10	10 16 39·0	,, 164	R	A 183	Dr	
224	Dec. 28	1 22 10·2	,, 1393	D	R 143	Dk	Very good.
225	28	2 26 31·6	,, 1393	R	R 143	Dk	
226	30	0 59 10·3	,, 1521	D	R 143	Dk	
227	30	0 59 10·9	,, 1521	D	A 110	Dr	

Observers :
Bn=T. A. Banachiewicz.
Br=V. A. Baranov.
G=M. A. Gratchev.
Db=A. D. Dubiago.
Dk=I. A. Dukov.
Dr=K. K. Dubrovsky.
H=M. K. Hrabak.
J=A. A. Jakovkin.
M=M. M. Musselius.
P=Miss O. I. Pestrikov.
T=N. V. Trofimov.
Z=V. M. Zlatinsky.

Instruments used :
A=Astrographic (110 mm.).
F=Fraunhofer telescope (96 mm.).
H=Heliometer (106 mm.).
K=Merz cometseeker (95 mm.).
R=Refractor (306 mm.).
Rs=Refractorseeker (135 mm.).
Z=Zeiss telescope (68 mm.).

Engelhardt Observatory :
1926 *June* 27.

Occultations of Stars by the Moon, observed at the Nizamiah Observatory, Hyderabad, during the years 1924 *and* 1925.

(*Communicated by the Director.*)

No.	Date.	Star.	Mag.	Phase.	Greenwich Mean Time. h m s	Observer.
1	1924 Mar. 17	o^2 Cancri	5·7	D	13 42 46·7	B
2	17	o^1 Cancri	5·1	R	14 33 11·7	B
3	May 15	γ Virginis A	2·9	D	15 18 10·0	B
4	15	γ Virginis B		D	15 18 34·5	B
5	15	γ Virginis A	2·9	R	16 3 41·1	B
6	15	γ Virginis B		R	16 3 48·1	B
7	1925 Feb. 3	*m* Tauri	5·0	D	14 14 48·5	B
8	3	*m* Tauri	5·0	R	15 6 7·1	B
9	4	64 Orionis	5·1	D	18 17 54·2	M
10	4	64 Orionis	5·1	R	19 42 8·1	M
11	7	θ Cancri	5·5	D	14 15 39·9	B
12	7	θ Cancri	5·5	R	15 41 13·2	B
13	11	*b* Virginis	5·2	D	22 5 36·7	M
14	11	*b* Virginis	5·2	R	23 34 44·9	M

Instrument used :—15-inch Grubb Refractor, power 90.
Observers :—T. P. Bhaskaran—B. ; M. K. Bappn—M.

Notes.

Nos. 1, 2, 8, 11, 12: fair. Nos. 3, 4, 7: instantaneous. Nos. 9, 13: good.

Nizamiah Observatory,
Hyderabad, Deccan :
1926 *May.*

On the Centre of the Local Star System. By Dr. E. A. Kreiken.

(*Communicated by the Secretaries.*)

In the *Monthly Notices* of March 1925 (**85**, 499–507) the distribution of the stars in the galactic plane, with $|\beta| < 10°$ and β from $|10°|$ to $|20°|$ and with magnitude $m < 15{\cdot}00$, was investigated. The star numbers were obtained from counts in the Harvard-Groningen Durchmusterung of Selected Areas.

In the same volume of the *M.N.* (No. 9, pp. 985–997) the same was done for the stars of separate spectral types brighter than $m = 8\frac{1}{2}$ and with galactic latitude between the limits $-30°$ to $-10°$; $-10°$ to $+10°$; and $+10°$ to $+30°$. The material for this second investigation was obtained from the Henry Draper Catalogue.

In both cases, curves of equal density were derived. From these there appears the marked eccentric position of the sun in the local star-system. The frequent occurrence of dark nebular clouds in the Milky Way, and the difference in the distribution of the stars south and north of the galactic plane (cf. *M.N.*, **85**, pp. 986 and 988, figs. 1 and 3), makes it desirable to investigate whether an elongation in the direction λ about 270° also occurs in the higher latitudes.

Therefore I have discussed in the present paper the distribution of all stars down to $m = 17$ in the whole sky.

The material has been taken from the Harvard-Groningen Durchmusterung of Selected Areas and from the article of Seares, van Rhijn, Joyner, and Richmond, in the *Astrophysical Journal*, December 1925, pp. 320–374, which contains the star numbers in the M.W. Catalogue generally down to magnitude 18·0. The magnitude scale of the Harvard-Groningen Durchmusterung has been brought into agreement with that of the M.W. Catalogue, which is on the international photographic scale. Details of this reduction are given below.

The whole sky has been divided into fifty-six regions. The galactic longitudes and latitudes are given in Table I., together with the number of areas they contain. For each region I have derived the values $\log N_m$ for $m = 10, 11, 12, \ldots 17$. From the $\log N_m$ the apparent luminosity curves are obtained, which again have been used in deriving the density-functions. From these functions we find the curves of equal density shown in figs. 2–7.

The Star Counts.—I have counted the number of stars which are brighter than the 10th, 11th, . . . 15th magnitude in each area of the Harvard-Groningen Durchmusterung. The numbers for the areas situated in one region of Table I. were combined into one set, and from these total numbers the value $\log N_m$ per square degree was derived.

The corresponding values for the M.W. Catalogue were found by simply taking the mean of the cumulative sums in tables 1*a* and 1*b* in the *Astrophysical Journal* (December 1925, pp. 324–333).

These totals were also combined into one set for the different regions of Table I., and they directly gave $\log N_m$ (m 13, 14, . . . 18). The M.W. areas are on the whole complete down to $m = 18{\cdot}0$, and so contain

a far greater number of faint stars than the Harvard-Groningen Durchmusterung. The disadvantage of the lists of Seares, van Rhijn, Joyner, and Richmond is that they contain only the areas 1–140.

Reduction of the Magnitude Scale of the Harvard-Groningen Durchmusterung.—In table xviii. of the above quoted article by Seares and others, the value of log N_m is given for different magnitudes in the zones of latitude 40°–90°, 20°–40°, and 0°–20°.

From this table the international magnitudes corresponding to m 10, 11, . . . 15 on the Harvard-Groningen scale were found by combining the star numbers of all Harvard-Groningen areas in these three latitude-zones and deriving the mean value log N_m. The results are given in Table II. The right side of the table contains the corrections to be applied to the scale of the Harvard-Groningen Durchmusterung. They were found by interpolation from table xviii. (*loc. cit.*).

The final correction which has been applied is simply the mean of the corrections found in the three different zones. The last line of Table II. contains the correction previously derived by Seares. It may be noted, that for the brighter m the corrections given here are larger than the corresponding ones of Seares. This is due to the fact that the central star in each area is always a bright one. The number of bright stars is therefore found statistically too large and so is the correction. In the numbers of the fainter m the influence of the excess of brighter stars is negligible, and my corrections are nearly equal to those derived by Seares.

The Values of Log N_m.—In each of the fifty-six regions given in Table I. the star numbers of these areas were combined into one set. From these total numbers we find the value log N_m after having taken into account the surface covered by each area. The Harvard-Groningen counts give the values log N_m for m = 10·56, 11·52, . . . 15·28 (Int. Scale). The M.W. counts give the corresponding values for m=13·0, 14·0, . . . 18·0.

With these values, log N_m per square degree, diagrams were made in which log N_m was plotted against magnitude. Through the points found in this way, smooth curves were drawn. In those regions where M.W. counts are available, the curves cover the whole interval from m=10 to m=18·0. For the other regions the fainter limit is the 15·28th magnitude. I have, however, extrapolated these curves down to the magnitude 17·0.

From the different curves obtained in this way the values log N_m, which are given in Table III., were read.

For the M.W. regions the fainter limit of the table is m=18·0; for all the others m=17·0.

TABLE I.

Situation of the Different Regions. Number of the Regions and Number of Areas each contains (in parentheses).

Gal. Latitude \ Gal. Longitude	0°.	60°.	120°.	180°.	240°.	300°.	360°.
+90°							
+80	Region 1 (1)						
	2 (3)		3 (4)		4 (4)		
+60	5 (4)	6 (4)	7 (5)	8 (4)	9 (5)	10 (4)	
+40	11 (6)	12 (3)	13 (6)	14 (5)	15 (4)	16 (4)	
+20	17 (4)	18 (4)	19 (3)	20 (3)	21 (5)	22 (2)	
+10	23 (4)	24 (2)	25 (2)	26 (3)	27 (2)	28 (3)	
0	29 (2)	30 (3)	31 (2)	32 (2)	33 (2)	34 (3)	
−10	35 (4)	36 (5)	37 (2)	38 (4)	39 (3)	40 (3)	
−20	41 (6)	42 (4)	43 (5)	44 (5)	45 (4)	46 (5)	
−40	47 (3)	48 (3)	49 (5)	50 (3)	51 (4)	52 (4)	
−60	53 (4)		54 (4)		55 (6)		
−80	56 (2)						
−90							

The Surface Distribution of the Stars.—A superficial glance at the numbers of Table III. immediately shows the well-known decrease of log N_m with increasing latitude. A closer inspection shows that in the northern part of the sky the place of the minimum value of log N_m does not coincide with the pole of the Milky Way. This feature is specially marked for the magnitudes <15·0. In the latitude zone from +60° to +80° all values log N_m are smaller than the corresponding ones near the pole. For the fainter magnitudes this phenomenon seems to have disappeared.

The small number of areas involved in these higher latitudes would make us consider this effect as wholly accidental, if it were not that this same feature in the distribution of the brighter stars of different spectral types has been remarked several times by H. Shapley.

According to Shapley, the same holds good for the southern sky, but this does not show in our numbers.

Table III. also proves that galactic longitude plays an important part in the distribution of the stars. This is still more evident from fig. 1, where for the different latitudes the values of log N_m are plotted against longitude.

All curves show a maximum at λ about 300°, while a minimum is reached at λ about 150°. Relatively to the curves of the northern sky,

those of the southern hemisphere are shifted to somewhat greater longitude.

The fluctuations in the different curves given here strongly resemble

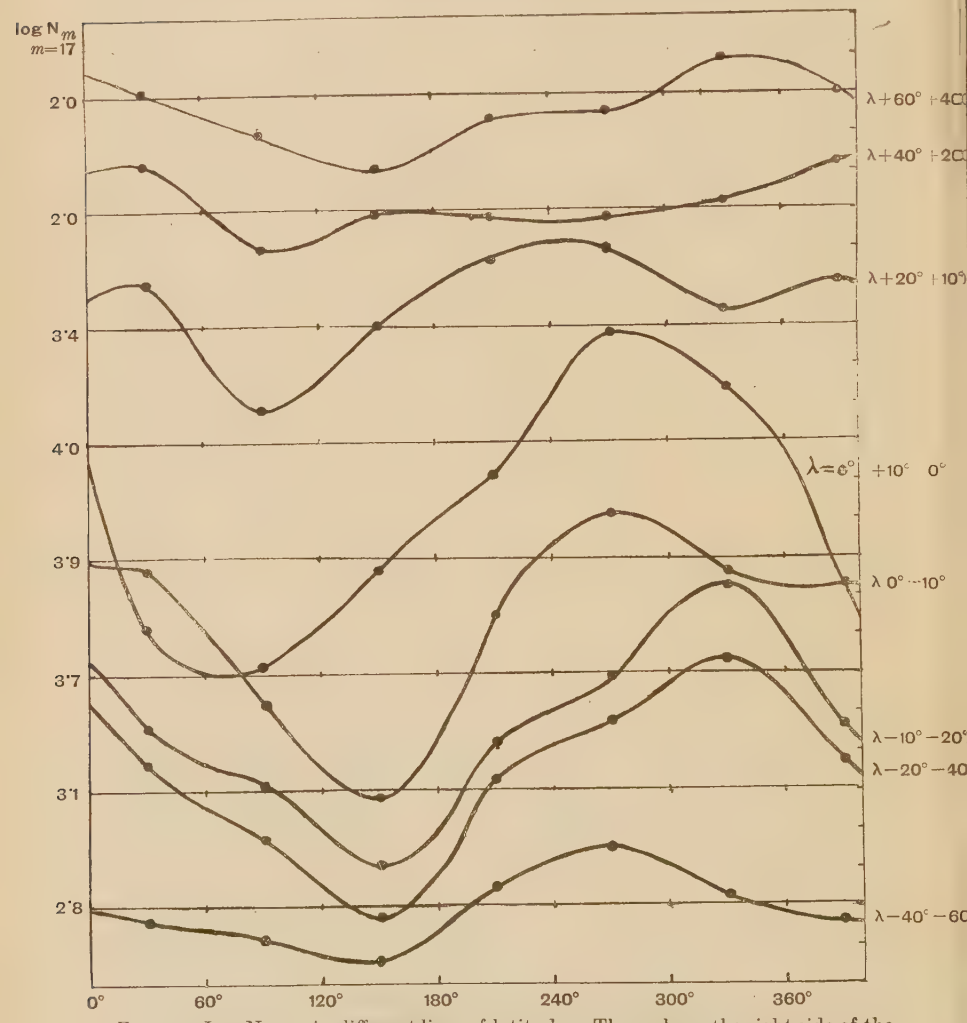


FIG. 1.—Log $N_{m=17}$ in different lines of latitude. The scale on the right side of the figure is such that the distance between two scale divisions corresponds to a difference of 0·1 in the logarithm.

those of the curves previously given in *M.N.*, **85**, pp. 500, 501, 986, and 987.

Comparing the amplitude of the fluctuations in the different curves, it appears (1) that the amplitude is greater in the lower latitudes, while

it decreases near the poles of the galaxy; (2) that in the curves for the southern sky the amplitude is larger than in the corresponding curves of the northern hemisphere. On the whole the surface density of the stars in the northern part of the sky is smaller than in the southern sky. Table IV. contains some results. In this table the mean values log N_m for the different zones of latitude have been entered. The values in Table IV. are based on counts in the Harvard-Groningen Durchmusterung only, as for the majority of the southern regions the M.W. Catalogue gives no data.

Nearly all differences south–north are positive. In the region $\beta = 10°$, however, the reverse seems to be the case. On the whole the absolute value of the differences increases with the fainter magnitude. With a view to the large accidental irregularities, it is not possible to give this conclusion in any definite form.

TABLE II.

Corrections to be applied to the Scale of the Harvard-Groningen Durchmusterung of Selected Stars.

	Log N_m per Sq. Degree.					
β \ m	10.	11.	12.	13.	14.	15.
90°–40°	0·571	0·945	1·304	1·633	1·916	2·204
40°–20°	0·787	1·200	1·577	1·894	2·212	2·534
20°– 0°	1·045	1·428	1·852	2·248	2·575	2·933

	Correction.						Number of Stars.
β \ m	10.	11.	12.	13.	14.	15.	
90°–40°	+·51	+·47	+·45	+·39	+·27	+·28	15,343
40°–20°	+·57	+·59	+·55	+·39	+·29	+·25	13,013
20°– 0°	+·59	+·50	+·47	+·49	+·35	+·30	16,761
Mean correction,	+·56	+·52	+·49	+·42	+·30	+·28	
Correction, Seares,	+·40	+·37	+·41	+·39	+·32	+·27	

TABLE III.

Log N_m per square degree.

(*The Galactic Latitudes and Longitudes of the different Regions are given in Table I.*)

m.	Region 1 (North Polar Cap).	
11	0·603	
12	1·040	
13	1·440	
14	1·767	$\beta > +80°$
15	2·048	
16	2·264	
17	2·462	
18	2·621	

TABLE III.—*continued.*

	Region 2.	Region 3.	Region 4.	
11	0·402	0·679	0·525	
12	0·873	1·042	0·964	
13	1·283	1·401	1·344	
14	1·662	1·733	1·695	
15	2·000	2·013	1·999	β from +80° to +60°
16	2·299	2·256	2·283	
17	2·562	2·487	2·561	
18	2·772	2·696	2·784	

	Region 5.	Region 6.	Region 7.	Region 8.	Region 9.	Region 10.	
11	0·664	0·744	0·659	0·742	0·656	0·621	
12	1·183	1·122	1·085	1·161	1·102	1·120	
13	1·508	1·482	1·481	1·540	1·505	1·568	
14	1·860	1·823	1·834	1·902	1·861	1·943	
15	2·179	2·158	2·143	2·221	2·183	2·284	β+60° to +40°
16	2·499	2·456	2·398	2·499	2·491	2·603	
17	2·804	2·719	2·601	2·740	2·763	2·899	
18	3·055	2·931	2·776	2·941	3·002	3·174	

	Region 11.	Region 12.	Region 13.	Region 14.	Region 15.	Region 16.	
11	1·067	0·948	0·855	0·836	0·835	0·840	
12	1·456	1·295	1·294	1·335	1·322	1·242	
13	1·817	1·618	1·716	1·742	1·798	1·645	
14	2·166	1·939	2·083	2·138	2·190	2·023	
15	2·481	2·258	2·455	2·466	2·500	2·379	β+40° to +20°
16	2·803	2·581	2·737	2·740	2·762	2·720	
17	3·134	2·896	3·000	2·984	2·987	3·057	
18	3·402	3·203	3·218	3·202	..	3·403	

TABLE III.—*continued.*

	Region 17.	Region 18.	Region 19.	Region 20.	Region 21.	Region 22.	
11	1·151	1·001	1·243	1·121	1·106	0·862	
12	1·600	1·359	1·635	1·608	1·665	1·309	
13	2·022	1·703	2·019	2·056	2·121	1·768	
14	2·420	2·220	2·396	2·480	2·563	2·226	
15	2·805	2·538	2·743	2·879	2·945	2·660	β +20° to +10°
16	3·176	2·864	3·082	3·255	3·300	3·068	
17	3·518	3·182	3·400	3·579	3·609	3·443	
18	3·837	3·521	3·678	3·856	..	..	

	Region 23.	Region 24.	Region 25.	Region 26.	Region 27.	Region 28.	
11	1·321	1·283	1·389	1·399	1·658	1·237	
12	1·759	1·681	1·873	1·939	2·241	1·781	
13	2·180	2·042	2·280	2·438	2·754	2·300	
14	2·520	2·393	2·654	2·876	3·215	2·763	
15	2·867	2·740	3·001	3·260	3·623	3·236	β +10° to 0°
16	3·193	3·081	3·341	3·603	3·998	3·699	
17	3·516	3·413	3·674	3·921	4·300	4·141	
18	3·800	3·740	3·978	..	..	..	

	Region 29.	Region 30.	Region 31.	Region 32.	Region 33.	Region 34.	
11	1·389	1·141	1·060	1·503	1·417	1·415	
12	1·896	1·634	1·516	1·974	1·940	1·906	
13	2·353	2·080	1·938	2·376	2·441	2·399	
14	2·781	2·500	2·319	2·765	2·907	2·840	
15	3·178	2·876	2·681	3·123	3·321	3·216	β −0° to −10°
16	3·562	3·220	3·003	3·460	3·700	3·543	
17	3·870	3·522	3·282	3·764	4·022	3·826	
18	4·209	3·764	..	..	..	..	

TABLE III.—*continued.*

	Region 35.	Region 36.	Region 37.	Region 38.	Region 39.	Region 40.	
11	1·142	1·095	0·878	1·079	1·100	1·258	
12	1·593	1·560	1·300	1·555	1·604	1·780	
13	2·022	1·987	1·719	2·010	2·114	2·265	
14	2·434	2·387	2·098	2·419	2·572	2·757	
15	2·823	2·759	2·440	2·815	2·961	3·162	$\beta -10°$ to $-20°$
16	3·219	3·096	2·839	3·182	3·342	3·563	
17	3·561	3·420	3·203	3·527	3·696	3·940	
18	3·936	3·705	3·578	..	..	..	

	Region 41.	Region 42.	Region 43.	Region 44.	Region 45.	Region 46.	
11	1·055	0·922	0·739	0·859	0·818	0·964	
12	1·438	1·361	1·117	1·308	1·340	1·441	
13	1·809	1·727	1·493	1·720	1·799	1·940	
14	2·164	2·078	1·858	2·122	2·222	2·379	
15	2·503	2·399	2·197	2·506	2·614	2·783	$\beta -20°$ to $-40°$
16	2·856	2·684	2·498	2·839	2·960	3·123	
17	3·180	2·963	2·781	3·141	3·282	3·441	
18	3·481	3·204	3·044	..	..	..	

	Region 47.	Region 48.	Region 49.	Region 50.	Region 51.	Region 52.	
11	0·743	0·763	0·760	0·721	0·719	0·742	
12	1·116	1·158	1·158	1·123	1·181	1·235	
13	1·499	1·495	1·537	1·538	1·615	1·665	
14	1·837	1·828	1·862	1·923	1·983	2·036	
15	2·161	2·145	2·163	2·279	2·340	2·341	$\beta -40°$ to $-60°$
16	2·478	2·442	2·421	2·600	2·663	2·605	
17	2·760	2·723	2·662	2·863	2·961	2·824	
18	3·007	2·986	2·879	..	..	..	

TABLE III.—*continued.*

	Region 53.	Region 54.	Region 55.	
	0·782	0·703	0·708	
11				
	1·133	1·087	1·099	
12				
	1·456	1·436	1·483	
13				
	1·782	1·755	1·822	
14				
	2·037	2·040	2·120	$\beta -60°$ to $-80°$
15				
	2·283	2·276	2·359	
16				
	2·518	2·448	2·574	
17				
	2·721	..	..	
18				

	Region 56 (South Polar Cap).	
	0·680	
11·0		
	1·039	
12·0		
	1·376	
13·0		
	1·680	$\beta < -80°$
14·0		
	1·962	
15·0		
	2·227	
16·0		
	2·460	
17·0		

TABLE IV.

The Values log N_m *for the different Zones of Galactic Latitude.*

m Harv.-Gr. Scale. / *m* Intern. Scale. / Galactic Latitude.	10. 10·56.	11. 11·52.	12. 12·49.	13. 13·42.	14. 14·30.	15. 15·28.
$\beta > +80°$	0·528	0·704	1·269	1·549	1·822	2·074
$\beta < -80°$	0·528	0·771	1·300	1·560	1·809	2·067
$\beta +60°$ to $+80°$	0·457	0·839	1·179	1·524	1·795	2·062
$\beta -60°$ to $-80°$	0·577	0·918	1·309	1·665	1·916	2·173
$\beta +40°$ to $+60°$	0·573	0·939	1·325	1·645	1·945	2·250
$\beta -40°$ to $-60°$	0·625	1·014	1·382	1·766	2·058	2·323
$\beta +20°$ to $+40°$	0·768	1·163	1·574	1·919	2·236	2·555
$\beta -20°$ to $-40°$	0·765	1·178	1·584	1·975	2·312	2·636
$\beta +10°$ to $+20°$	0·970	1·324	1·773	2·182	2·514	2·888
$\beta -10°$ to $-20°$	0·954	1·311	1·793	2·242	2·627	3·031
β 0° to $+10°$	1·248	1·650	2·099	2·536	2·910	3·297
β 0° to $-10°$	1·146	1·573	2·058	2·476	2·825	3·181

TABLE V.

The Coefficients α, β, and γ of the Apparent Photographic Luminosity-curves.

	Region 1.
α	+1·842
β	+0·290
γ	0·026

	Region 2.	Region 3.	Region 4.
α	+1·663	+1·720	+1·690
β	+0·358	+0·304	+0·338
γ	−0·020	−0·016	−0·017

	Region 5.	Region 6.	Region 7.	Region 8.	Region 9.	Region 10.
α	+1·878	+1·833	+1·834	+1·891	+1·845	+1·926
β	+0·349	+0·329	+0·328	+0·334	+0·352	+0·379
γ	−0·014	−0·013	−0·024	−0·019	−0·018	−0·019

	Region 11.	Region 12.	Region 13.	Region 14.	Region 15.	Region 16.
α	+2·150	+1·940	+2·124	+2·123	+2·056	+2·018
β	+0·341	+0·324	+0·365	+0·358	+0·358	+0·371
γ	−0·007	−0·002	−0·026	−0·023	−0·032	−0·007

	Region 17.	Region 18.	Region 19.	Region 20.	Region 21.	Region 22.
α	+2·421	+2·151	+2·396	+2·484	+2·565	+2·223
β	+0·396	+0·373	+0·356	+0·409	+0·414	+0·434
γ	−0·010	−0·009	−0·010	−0·016	−0·023	−0·008

	Region 23.	Region 24.	Region 25.	Region 26.	Region 27.	Region 28.
α	+2·541	+2·406	+2·647	+2·873	+3·217	+2·773
β	+0·366	+0·356	+0·378	+0·418	+0·439	+0·481
γ	−0·015	−0·007	−0·013	−0·024	−0·026	−0·009

	Region 29.	Region 30.	Region 31.	Region 32.	Region 33.	Region 34.
α	+2·769	+2·489	+2·325	+2·769	+2·905	+2·831
β	+0·415	+0·396	+0·371	+0·375	+0·437	+0·405
γ	−0·015	−0·020	−0·017	−0·015	−0·021	−0·024

	Region 35.	Region 36.	Region 37.	Region 38.	Region 39.	Region 40.
α	+2·430	+2·386	+2·080	+2·421	+2·556	+2·735
β	+0·406	+0·387	+0·382	+0·407	+0·432	+0·450
γ	−0·008	−0·015	−0·003	−0·013	−0·018	−0·015

	Region 41.	Region 42.	Region 43.	Region 44.	Region 45.	Region 46.
α	+2·346	+2·077	+1·858	+2·123	+2·224	+2·347
β	+0·355	+0·338	+0·342	+0·382	+0·409	+0·416
γ	−0·007	−0·015	−0·012	−0·013	−0·019	−0·020

TABLE V.—*continued.*

	Region 47.	Region 48.	Region 49.	Region 50.	Region 51.	Region 52.
α	+1·854	+1·845	+1·870	+1·924	+1·991	+2·029
β	+0·339	+0·342	+0·320	+0·362	+0·372	+0·345
γ	−0·014	−0·014	−0·019	−0·015	−0·017	−0·027

	Region 53.	Region 54.	Region 55.
α	+1·919	+1·750	+1·818
β	+0·293	+0·294	+0·312
γ	−0·016	−0·020	−0·020

	Region 56.
α	+1·680
β	+0·297
γ	−0·012

TABLE VI.

The Coefficients of the Density-Functions.

	Region 1.
ϱ_0	13·76
l	+0·182
k	−0·440
h	−0·475

	Region 2.	Region 3.	Region 4.
ϱ_0	15·34	14·76	15·25
l	+0·061	+0·037	+0·042
k	−0·322	−0·362	−0·328
h	−1·337	−1·262	−1·347

	Region 5.	Region 6.	Region 7.	Region 8.	Region 9.	Region 10.
ϱ_0	15·63	15·47	14·53	15·14	15·44	15·87
l	+0·030	+0·024	+0·125	+0·053	+0·048	+0·053
k	−0·302	−0·313	−0·378	−0·336	−0·315	−0·285
h	−1·316	−1·365	−0·821	−1·081	−1·234	−1·215

	Region 11.	Region 12.	Region 13.	Region 14.	Region 15.	Region 16.
ϱ_0	15·89	16·09	15·05	15·14	14·50	16·54
l	+0·010	+0·002	+0·003	+0·091	+0·200	+0·010
k	−0·284	−0·270	−0·342	−0·336	−0·380	−0·239
h	−1·200	−1·523	−0·970	−0·723	−0·873	−1·417

	Region 17.	Region 18.	Region 19.	Region 20.	Region 21.	Region 22.
ϱ_0	16·70	16·51	16·09	16·56	16·24	17·47
l	+0·016	+0·014	+0·016	+0·037	+0·091	+0·012
k	−0·228	−0·241	−0·270	−0·238	−0·260	−0·175
h	−0·970	−1·265	−0·940	−0·782	−0·509	−1·287

TABLE VI.—*continued.*

	Region 23.	Region 24.	Region 25.	Region 26.	Region 27.	Region 28.
ϱ_0	15·86	16·31	16·21	16·14	16·43	18·17
l	+0·033	+0·010	+0·026	+0·125	+0·167	+0·014
k	−0·286	−0·255	−0·262	−0·267	−0·247	−0·127
h	−0·637	−0·901	−0·646	−0·102	+0·254	−0·721

	Region 29.	Region 30.	Region 31.	Region 32.	Region 33.	Region 34.
ϱ_0	16·72	16·05	16·00	16·21	16·51	16·58
l	+0·033	+0·059	+0·042	+0·033	+0·071	+0·125
k	−0·227	−0·273	−0·276	−0·262	−0·241	−0·236
h	−0·526	−0·642	−0·858	−0·487	−0·228	−0·280

	Region 35.	Region 36.	Region 37.	Region 38.	Region 39.	Region 40.
ϱ_0	16·76	16·72	16·69	16·79	16·83	17·27
l	+0·012	+0·033	+0·003	+0·024	+0·048	+0·033
k	−0·224	−0·227	−0·229	−0·222	−0·219	−0·189
h	−0·995	−0·967	−1·394	−0·969	−0·705	−0·622

	Region 41.	Region 42.	Region 43.	Region 44.	Region 45.	Region 46.
ϱ_0	16·29	15·43	15·69	16·28	16·41	16·41
l	+0·010	+0·033	+0·017	+0·024	+0·053	+0·063
k	−0·256	−0·316	−0·298	−0·257	−0·248	−0·248
h	−1·053	−1·034	−1·381	−1·168	−0·976	−0·816

	Region 47.	Region 48.	Region 49.	Region 50.	Region 51.	Region 52.
ϱ_0	15·47	15·51	14·79	17·25	17·35	14·54
l	+0·030	+0·030	+0·053	+0·033	+0·042	+0·250
k	−0·313	−0·310	−0·360	−0·290	−0·283	−0·377
h	−1·298	−1·306	−1·034	−1·262	−1·190	−0·469

	Region 53.	Region 54.	Region 55.
ϱ_0	14·60	14·24	14·51
l	+0·037	+0·062	+0·062
k	−0·373	−0·398	−0·379
h	−1·059	−0·972	−0·977

	Region 56.
ϱ_0	14·89
l	+0·017
k	−0·353
h	−1·432

TABLE VII.

Curves of Equal Density. Values of ϱ for which log D(ϱ) *is equal to* 9·8, 9·6, . . . 8·0.

log D(ϱ).	Region 1.	
9·8	12·70	
9·6	13·47	
9·4	13·96	
9·2	14·29	$\beta > +80°$
9·0	14·61	
8·5	15·26	
8·0	15·76	

	Region 2.	Region 3.	Region 4.	
9·6	..	10·75	..	
9·4	..	12·26	..	
9·2	..	13·00	..	$\beta +60°$ to $+80°$
9·0	13·84	13·95	13·95	
8·5	15·77	15·24	15·66	
8·0	16·89	16·40	16·87	

	Region 5.	Region 6.	Region 7.	Region 8.	Region 9.	Region 10.	
9·6	..	10·83	..	..	..	..	
9·4	11·65	12·19	13·60	13·02	..	..	
9·2	13·04	13·17	14·24	13·97	13·44	..	$\beta +40°$ to $+60°$
9·0	14·63	14·16	14·89	14·91	14·56	14·97	
8·5	16·19	15·87	15·76	16·20	16·18	16·71	
8·0	16·66	17·24	16·41	17·22	17·32	17·87	

	Region 11.	Region 12.	Region 13.	Region 14.	Region 15.	Region 16.	
9·8	11·80	..	12·70	..	..	..	
9·6	12·75	11·80	13·36	..	..		
9·4	13·44	12·59	13·97	14·64	..	12·44	
9·2	14·39	13·35	14·55	15·32	14·09	13·55	$\beta +20°$ to $+40°$
9·0	15·16	14·10	15·15	15·79	14·72	14·64	
8·5	16·89	16·00	16·55	16·71	15·50	16·87	
8·0	18·71	17·84	18·04	17·45	16·00	18·66	

	Region 17.	Region 18.	Region 19.	Region 20.	Region 21.	Region 22.	
9·8	..	..	12·62	..	..	..	
9·6	13·44	..	13·75	..	..	..	
9·4	14·82	13·01	14·70	15·65	16·50	..	
9·2	15·90	14·28	15·54	16·63	17·07	13·70	$\beta +10°$ to $+20°$
9·0	16·84	15·32	16·30	17·35	17·84	15·58	
8·5	18·70	17·42	17·95	18·79	18·64	18·59	
8·0	20·30	19·14	19·36	19·92	(19·14)	20·78	

TABLE VII.—*continued.*

	Region 23.	Region 24.	Region 25.	Region 26.	Region 27.	Region 28.	
9·8	13·87	13·55	14·02	16·20	17·45	..	
9·6	14·94	14·21	15·13	16·90	17·75	..	
9·4	15·71	15·06	16·02	17·24	18·02	17·10	
9·2	16·40	15·90	16·75	17·62	18·33	18·83	β 0° to +10°
9·0	16·97	16·69	17·37	18·00	18·53	19·97	
8·5	18·21	18·47	18·78	18·36	18·86	22·35	
8·0	19·26	(20·06)	19·96	(19·00)	19·44	(24·38)	

	Region 29.	Region 30.	Region 31.	Region 32.	Region 33.	Region 34.	
9·8	14·72	..	..	14·85	16·35	15·87	
9·6	16·07	14·75	..	15·83	17·01	16·68	
9·4	17·00	15·85	14·84	16·69	17·64	17·47	
9·2	17·76	16·52	15·75	17·24	18·13	17·84	β −10° to 0°
9·0	18·38	17·10	16·56	17·82	18·51	18·17	
8·5	19·72	18·08	17·81	19·05	19·36	18·88	
8·0	20·80	19·05	18·87	20·09	20·06	19·50	

	Region 35.	Region 36.	Region 37.	Region 38.	Region 39.	Region 40.
9·6	13·54	13·80	..	..	..	15·47
9·4	14·77	14·90	13·03	16·08	16·21	17·13
9·2	15·80	15·81	14·00	17·17	17·18	18·07
9·0	16·76	16·82	14·79	17·95	17·91	18·81
8·5	18·76	18·56	17·12	19·38	19·21	20·30
8·0	20·31	19·82	19·25	20·81	20·19	21·50

	Region 41.	Region 42.	Region 43.	Region 44.	Region 45.	Region 46.
9·8	12·39					
9·6	13·51	12·49				
9·4	14·49	13·70	12·17	13·14	..	14·91
9·2	15·28	14·58	13·44	14·48	15·51	16·32
9·0	16·07	15·34	14·09	15·57	16·49	17·00
8·5	17·93	16·72	16·07	17·54	17·98	18·27
8·0	19·56	17·87	17·56	18·87	19·03	19·19

	Region 47.	Region 48.	Region 49.	Region 50.	Region 51.	Region 52.
9·6	..	..	..	..	..	14·09
9·4	..	..	13·16	12·75	..	14·75
9·2	13·50	13·47	14·03	15·14	15·40	15·07
9·0	14·41	14·39	14·68	16·25	16·53	15·39
8·5	16·06	16·08	15·90	17·99	18·30	15·90
8·0	17·38	17·40	16·84	19·27	19·58	16·34

TABLE VII.—*continued.*

	Region 53.	Region 54.	Region 55.
9·8	10·96	..	..
9·6	12·28	11·96	11·51
9·4	13·10	13·07	13·21
9·2	13·93	13·66	13·88
9·0	14·43	14·26	14·56
8·5	15·69	15·36	15·66
8·0	16·70	16·21	16·56

	Region 56.
9·6	11·35
9·4	12·17
9·2	12·91
9·0	13·56
8·5	15·05
8·0	16·38

TABLE VIII.

Position of the Centre of Local System.

Plane.	Galactic Longitude.	Distance in Parsecs.
500 parsecs north	315°	2300
In the galaxy	310	2100
500 parsecs south	324	2500
Final value	314	2260

The Apparent Luminosity Curves.—It appears that the values of log N_m in each region of Table III. may be analytically represented with sufficient accuracy by the usual formula,

$$\log N_m = \alpha + \beta(m - m_0) + \gamma(m - m_0)^2.$$

In the present article I took $m_0 = 14$, so we have

$$\log N_m = \alpha + \beta(m - 14) + \gamma(m - 14)^2 \quad . \quad . \quad (1)$$

The values of the coefficients α, β, and γ, which were derived for each region separately, are given in Table V.

The magnitudes of the M.W. Durchmusterung are on the international photographic scale. In the following we need the visual curve.

In *M.N.*, **85**, 505, I have used the formula

$$m_{ph} - m_{vis} = +0{\cdot}52 + 0{\cdot}05(m_{ph} - 12)$$

when passing from photographic to visual magnitude.

More recently the relation of mean colour to magnitude for all

longitudes and latitudes together was determined by F. Seares in *M.W. Contributions*, No. 287, where he found that the correction

$$-0{\cdot}16-0{\cdot}050m \quad . \quad . \quad . \quad . \quad (2)$$

applied to the argument, transforms a grouping according to photographic magnitude into one according to the visual scale. Seares' formula (2) was used in the present discussion. As the formula (2) is a mean for the whole sky we must expect, according to Seares, that for lower latitudes the correction will turn out to be somewhat smaller. On the other hand, the higher latitudes will probably require a larger correction.

When we write for the visual curve the form (3)

$$\log N_{m\,vis}=\alpha'+\beta'(m_v-14)+\gamma'(m_v-14)^2 \quad . \quad . \quad (3)$$

we find for the relation between α, β, γ and α', β', γ' the equations (4)

$$\left.\begin{aligned}\gamma'&=\frac{\gamma}{0{\cdot}903}\\ \beta'&=\frac{\beta}{0{\cdot}95}+1{\cdot}90\times\gamma\\ \alpha'&=\alpha+0{\cdot}905\beta+0{\cdot}815\gamma\end{aligned}\right\} \quad . \quad . \quad . \quad (4)$$

If we write

$$A_{(m)}=a+b(m-14)+c(m-14)^2=\frac{\partial N_m}{\partial m} \quad . \quad . \quad (5)$$

the values of a, b, and c are found by (6)

$$\left.\begin{aligned}a&=\alpha'-\log\log e+\log\beta'\\ b&=\beta'+\frac{2\gamma'}{\beta'}\log e\\ c&=\gamma'-\frac{2\gamma'^2}{\beta'^2}\log e\end{aligned}\right\} \quad . \quad . \quad . \quad (6)$$

The Density-Function.—If we put the absolute luminosity curve

$$\left.\begin{aligned}&\log\phi(M)=p+qM-rM^2\\ &(p=-2{\cdot}394\,;\quad q=+0{\cdot}186\,;\quad r=0{\cdot}0345)\end{aligned}\right\} \quad . \quad . \quad (7)$$

and the density curve

$$\left.\begin{aligned}&\log D(\rho)=h+k(\rho-\rho_0)-l(\rho-\rho_0)^2\\ &\rho=5\log r\,;\ r=\text{distance in parsecs}\end{aligned}\right\} \quad . \quad . \quad (8)$$

the coefficients of the formulæ 5, 7, and 8 are connected by the well-known Schwarzschild equations, which I give here in the form in which Dr. A. Pannekoek has used them :

$$\left.\begin{aligned}\rho_0&=m_0+\frac{b-0{\cdot}186}{0{\cdot}069} \qquad \frac{1}{l}=\frac{1}{c}-29\\ k&=b-0{\cdot}6 \qquad h=a+4{\cdot}937-0{\cdot}6m_0+\frac{k^2}{0{\cdot}138}+\tfrac{1}{2}\log(l+0{\cdot}0345)\end{aligned}\right\} \quad (9)$$

With the foregoing formulæ I computed in each region the coefficients ρ_0, l, k, and h of the density-function.

Table VI. gives the results.

In some instances the value of c is nearly $\frac{1}{29}$. In these cases small

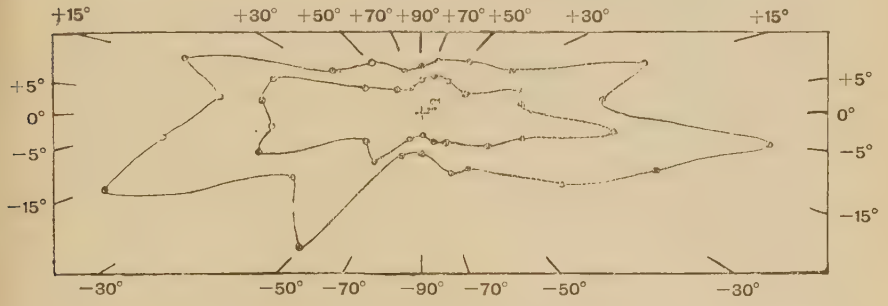


Fig. 2.—Lines of equal density in a plane perpendicular to the Milky Way in the direction $\lambda = 30° - 210°$ and going through the sun (S).

fluctuations of c will give large variations in the computed value of c, which in these cases will have but low weight.

The Curves of Equal Density.—The coefficients in Table VI. enable us to compute the space density in the different regions for different values of ρ.

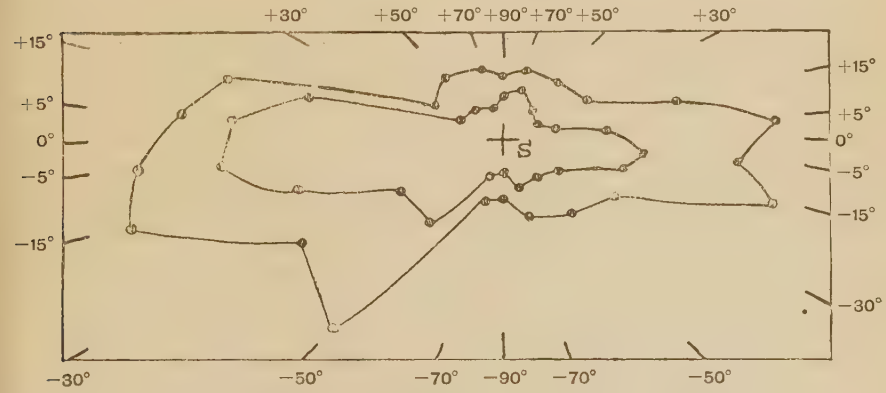


Fig. 3.—Lines of equal density in plane perpendicular to the Milky Way in the direction $\lambda = 90° - 270°$ and going through the sun (S).

From these computed densities we find, by interpolation, for which values of ρ the log $D(\rho)$ has respectively the values 9·8; 9·6; 9·4; 9·2; 9·0; 8·5.

The results have been tabulated in Table VII.

From the data in Table VII. we are able to draw the different curves of equal density in figs. 2, 3, and 4.

Fig. 2 shows a cross-section through the stellar system at right angles

to the galactic plane and in the direction of longitude $\lambda=30°$ to $\lambda=210°$. The black dots in figs. 2, 3, and 4, through which the curves of equal density were drawn, indicate the distances from the sun in parsecs in the direction $\beta=\pm5°$; $\pm15°$; $\pm30°$; $\pm50°$; $\pm70°$, and $\pm90°$, on which $\log D(\rho)=9{\cdot}0$ and $=8{\cdot}5$.

The right side of the figure contains the values of the first column of Table VII., while the left side contains the values of column 4. In exactly the same manner the curves in fig. 3 were obtained from the numbers in columns 2 and 5, and those in fig. 4 from columns 3 and 6.

The general shapes of the curves strongly resemble the elliptical curves previously derived by Kapteyn and van Rhijn for all longtiudes and latitudes together. In the direction of the pole of the galaxy the dimensions of the stellar universe are rather small, while a great extension is found along the plane of the Milky Way. This extension is greatest in the longitude 330°, in which longitude we expect to find the centre of the local star system.

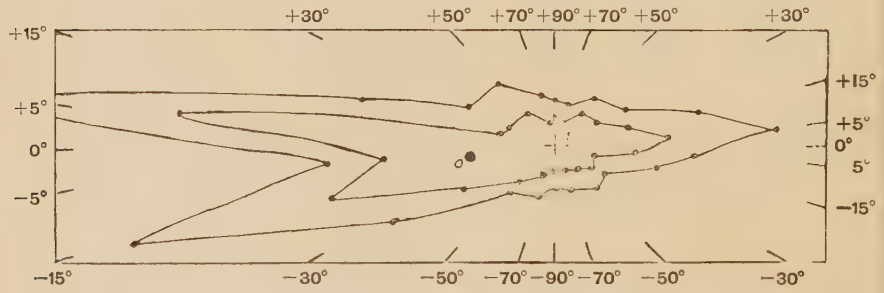


FIG. 4.—Lines of equal density in a plane perpendicular to the Milky Way in the direction $\lambda=150°-330°$ and going through the sun (S).

The curves show many irregularities, some of which may be due to local disturbances such as star clouds.

The deficiencies in the plane of the Milky Way are of special interest at longitudes 330° and 30°, and probably indicate the great dark rift in the Milky Way in the longitudes 340°–20°, which has long been considered an effect of obscuring matter. As our curves are based on numbers found from longitude intervals, which are rather large (60° wide), the irregularities at $\lambda=90°$ and $=210°$ may be caused by this same feature. They are less pronounced than in the other longitudes already mentioned.

From figs. 2, 3, and 4 it appears that the position of the sun in our local system is widely eccentric. This is even more evident from figs. 5, 6, and 7, in which I give the equal-density curves in three planes, from which the first is 500 parsecs to the north of the galactic plane and parallel to it (fig. 5), the second coincides with it (fig. 6), and the third is 500 parsecs to the south and running also parallel to the galactic plane.

The points, through which these latter equal-density curves were drawn, were found from figs. 2, 3, and 4 by determining the points of intersection of the curves in figs. 2, 3, and 4 with the three planes men-

tioned above. We measured the distances from these points of intersection to the vertical line through the sun (S). Figs. 5, 6, and 7

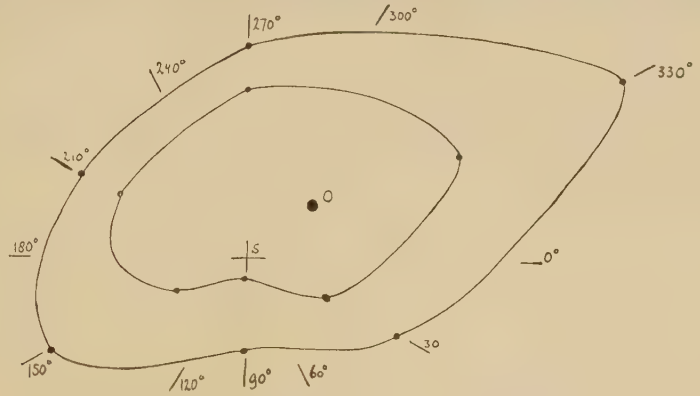


Fig. 5.—Lines of equal density in plane ‖ to the Milky Way and 500 parsecs north of it.

S=projection of the sun on this plane.
O=projection of the apparent star centre.

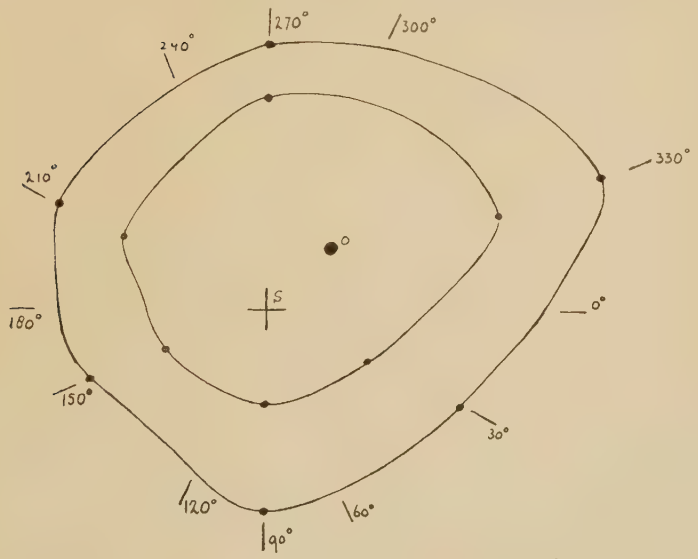


Fig. 6.—Lines of equal density in the galactic plane.

S=position of the sun.
O=apparent position of the star centre.

show these distances for the different longitudes. The centre of these figures is the sun or the point of intersection of the vertical line through the sun with the three planes. In figs. 5 and 6 the great

elongation of our local system in the direction λ about 315° is very evident, and it is in this direction that we must expect to find the centre of our star system. In fig. 7 the influence of the great dark rift in the Milky Way, between the longitudes 320° 30°, is manifested, while the Taurus nebulosity in galactic latitude −10°, longitude 130°–170°, also affects our curves.

From this it appears that these nebulosities have relatively small distances, which is in agreement with the results previously derived by Pannekoek, Shapley, and others. The dotted curves in fig. 7 were drawn

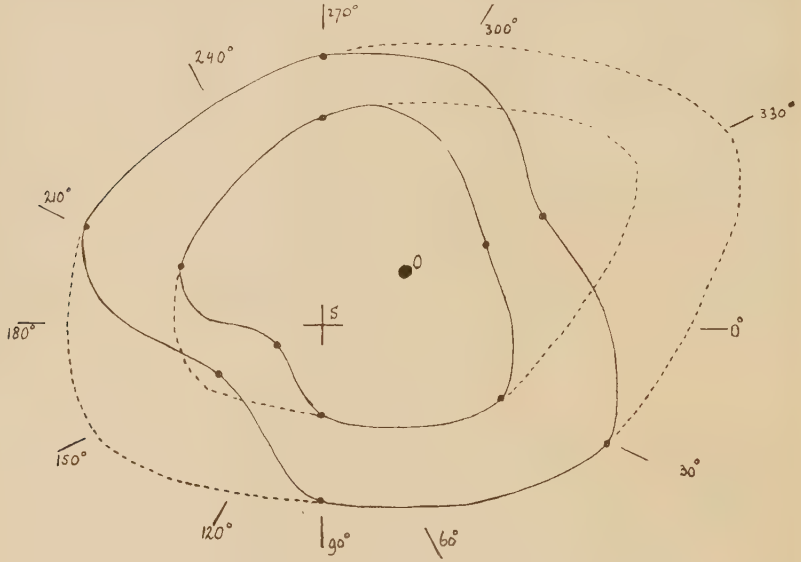


FIG. 7.—Lines of equal density in plane || to the Milky Way and 500 parsecs south of it.

S=projection of the sun on this plane.
O=projection of the apparent centre of star.

by analogy with those in figs. 5 and 6 and indicate how we might expect the equal-density curves to appear, without those absorbing nebulæ. Before drawing general conclusions from our different figures, it may be well to point out, that the very large extension of the curves in longitude 330° (fig. 4) must be greatly exaggerated by a defect of our formulæ. This is evident from the following considerations. For a moment we will consider the group of stars round the centre as a cloud of stars with a rather large spread in distance. Then in the direction of this centre, the observed numbers A(m) of the stars of each apparent magnitude will be equal to the sum of the cloud stars + the field stars of this magnitude. The large spread of the absolute-luminosity curve causes each value A(m) of the field stars to be multiplied by a constant factor. Therefore the apparent luminosity curve of field+cluster stars will be nearly the

same as that of the field stars, except for the constant term a, which in the former case will give a larger value (formula 5). Thus the constant term h of the density curve (formulæ 8, 9) will be found too large, and consequently all values log $D(\rho)$ will turn out somewhat larger. So we may say, that by our formula the dense group of stars near the centre is smoothed over the whole range of distance. Near the centre itself, the computed density will be too small, just as it will be too large nearer than and beyond the centre. The maximum which will be observed in all our density curves has no real meaning and does not give any evidence about the position of the star centre. It is a well-known defect of Kapteyn's density-function that it always gives zero density near the sun and a maximum at a relatively small distance from the sun, also an ever-decreasing density beyond this maximum. So the observed maximum should be expected from theory.

The Galactic Structure.—From figs. 2–7 we conclude that the irregularities in the surface distribution of the stars are mainly due to the following causes :—

1. The great abundance of stars in the Milky Way must be ascribed to the great extension of the stellar universe in the direction of the galactic plane, and to the condensation of the stars in this plane. This is a long-known fact.

2. In the distribution of the stars along the Milky Way longitude plays an important part, because of the eccentric position of the sun with respect to the general galaxy.

3. The local irregularities are due to the influence of the dark nebulosities in Taurus, Ophiuchus, etc.

This heterogeneity in the composition of the galactic system renders it very difficult to make a closer analysis of the galactic structure on the basis of the general star counts given here.

4. As, however, the question of the position of the sun with respect to the centre of the local system is very important, I have tried to get an approximate solution of it. Therefore the curves in figs. 4, 5, and 6 (in fig. 7 the dotted curves) have been analytically represented by ellipses. The centres of these ellipses were determined and have been indicated in the figures. The mean of the projections of these centres on the plane of the Milky Way must be considered as a preliminary solution for the situation of the centre of our local system with respect to the sun. The analysis gives the values in Table VIII. The final value was obtained by giving half weight to the solution for the plane 500 parsecs south of the galaxy and simply taking the mean of the different values.*

In view of the foregoing considerations as to the faults of the apparent luminosity curve, it may be expected that this final value is an upper limit.

5. From fig. 4 it appears that the sun is slightly north of the galactic plane. A crude estimation gives for the space density near the centre a value about twice as much as the density near the sun. With a view to the large uncertainties still remaining in our

* Half weight was given to the third solution, as we may expect the defects of the density-function, exposed before, to occur especially here.

solutions, very low weight should be attached to this value of the space density.

The main results of the present paper may be summarised in the following points :—

1. Adopting as centre of our local system the place where the star density is maximum, we find its galactic co-ordinates to be: longitude $=314^\circ$, latitude$=-6^\circ$, distance$=2270$ parsecs (which may be on the large side).

2. The eccentric position of the sun with respect to the local star system causes not only latitude but longitude to play an important part in the distribution of the stars.

3. As the position of the sun is about 250 parsecs north of the galactic plane, the star density in the northern sky is less than in the southern.

4. The position of the sun north of the galactic plane causes the distribution curves of the stars in fig. 1 for the high northern latitudes to be but faintly influenced by the dense group of stars near the centre of the local cluster. For the same reason the curves of the southern sky are strongly influenced.

5. In the northern sky the pole of the galaxy does not coincide with the place of minimum surface density. This latter is to be found in the direction about 150° at a latitude between 60° and 80°. When considering the position of the sun with respect to the centre we should expect to find this same position. As the distance from the sun to the border of the southern sky is larger than to the corresponding border in the northern, it is easily understood that in the southern sky the place of minimum density is shifted towards the pole.

6. The irregularities in the distribution curves not depending on longitude or latitude are due to local disturbances such as star clouds and absorbing nebulæ.

Haarlem :
1926 *July.*

A Method for Correcting Series of Parallax Observations.

By Sir Frank Dyson.

(1) In dealing with a series of observations of parallax, the question arises what is to be done with the negative parallaxes ? By a formula of Professor Eddington's from the apparent distribution of parallaxes, the true distribution may be inferred (*Greenwich Parallax Observations*, p. x). From this true distribution I inferred by a somewhat clumsy arithmetical method the mean errors of parallaxes of different amounts, but did not see how to obtain an algebraic solution. On referring the question to Professor Eddington he gave me a very simple and useful solution of the problem, which I have applied in this paper.

(2) Professor Eddington's solution is as follows :—

Let

$$u(x)dx = \text{true frequency}$$

and $v(x)dx$=measured frequency

of parallaxes between the limits x and $x+dx$.

Then

$$v(x)=\frac{h}{\sqrt{\pi}}\int_{-\infty}^{\infty}e^{-h^2\epsilon^2}u(x-\epsilon)d\epsilon$$

and the mean error

$$\bar{\epsilon}=\frac{\int_{-\infty}^{\infty}\epsilon e^{-h^2\epsilon^2}u(x-\epsilon)d\epsilon}{\int_{-\infty}^{\infty}e^{-h^2\epsilon^2}u(x-\epsilon)d\epsilon}.$$

The numerator may be integrated by parts, and

$$=\left[-\frac{1}{2h^2}e^{-h^2\epsilon^2}u(x-\epsilon)\right]_{-\infty}^{\infty}+\frac{1}{2h^2}\int_{-\infty}^{\infty}e^{-h^2\epsilon^2}\frac{d}{d\epsilon}u(x-\epsilon)d\epsilon.$$

The part in brackets vanishes and

$$\frac{d}{d\epsilon}u(x-\epsilon)=-\frac{d}{dx}u(x-\epsilon).$$

Thus

$$\bar{\epsilon}=-\frac{1}{2h^2}\frac{\frac{d}{dx}\int_{-\infty}^{\infty}e^{-h^2\epsilon^2}u(x-\epsilon)d\epsilon}{\int_{-\infty}^{\infty}e^{-h^2\epsilon^2}u(x-\epsilon)d\epsilon}$$

$$=-\frac{1}{2h^2}\frac{v'(x)}{v(x)}.$$

This formula for the mean error depends only on the *observed* distribution. It may be noticed that the formula is verified when the observed distribution is $e^{-h^2x^2}dx$, as the error in this case is, of course, x.

(3) This formula has been applied to the parallaxes determined at Greenwich, which have proper motions greater than 20″ a century. Most of the determinations have been already printed in the Greenwich volume of Parallax Observations; the others are identifiable by their B.D. numbers in Table II.

The distribution of the parallaxes considered is as follows :—

Limits of π.	Observed No.	Limits of π.	Observed No.	Limits of π.	Observed No.
″ > ″ ·200	1	″ ·025 to ″ ·030	23	−″·005 to ″ ·000	11
·100 to ·200	5	·020 ,, ·025	20	−·010 ,, −·005	7
·075 ,, ·100	5	·015 ,, ·020	28	−·015 ,, −·010	6
·050 ,, ·075	17	·010 ,, ·015	33	−·020 ,, −·015	0
·040 ,, ·050	17	·005 ,, ·010	18	−·025 ,, −·020	1
·030 ,, ·040	37	·000 ,, ·005	19		

These figures were plotted in fig. 1. Partly by a graphical process the values of $\frac{1}{2h^2}\frac{v'(x)}{v(x)}$ given in Table I. were then obtained. Corresponding to intervals of parallax of ″·005, and with an assumed probable error of ±″·008, this $=″·029\frac{\Delta y}{y}$.

TABLE I.

π.	Correction.	π.	Correction.	π.	Correction.
″	″	″	″	″	″
+·085	−·006	+·045	−·009	+·005	+·009
·080	−·006	·040	−·008	·000	+·011
·075	−·007	·035	−·007	−·005	+·014
·070	−·008	·030	−·006	−·010	+·018
·065	−·009	·025	−·005	−·015	+·023
·060	−·010	·020	−·003	−·020	+·028
·055	−·010	·015	+·000		
+·050	−·009	+·010	+·004		

(4) All observed values greater than ″·015 are reduced, and those less than ″·015 increased, and very considerably for those much below this value. Practically the correction clears out all the negative parallaxes and makes them ″·008 or ″·009. A very substantial reduction is made in the parallaxes between ″·040 and ″·070, but the fractional part of the parallax (which is the way in which the deduced absolute magnitudes and velocities are affected) diminishes fairly rapidly with the larger parallaxes.

(5) The resulting true distribution of the stars is as follows :—

Limits of π.	Number.	Limits of π.	Number.
″ > ″·200	1	″·025 to ″·030	24
·100 to ·200	4	·020 ,, ·025	36
·050 ,, ·100	11	·015 ,, ·020	72
·040 ,, ·050	12	·010 ,, ·014	55
·030 ,, ·040	24	·008 ,, ·009	16

These are *relative* parallaxes and a constant +″·003 is added to them in Table II.

(6) If the curve $y=v(x)$, giving the observed distribution of parallaxes, were drawn with sufficient accuracy, the correction could be obtained from the reciprocal of the intercept of the tangent to it on the axis of x. This is not, however, practicable where the curve is close to the axis of x. It is of some assistance in drawing the smoothed curve to note that at the negative end it must be of the form $Ae^{-k^2(x-a)^2}$.

The total amount of the correction between certain limits is

$$\frac{1}{2h^2}\frac{1}{y}\cdot\frac{dy}{dx}\cdot ydx$$

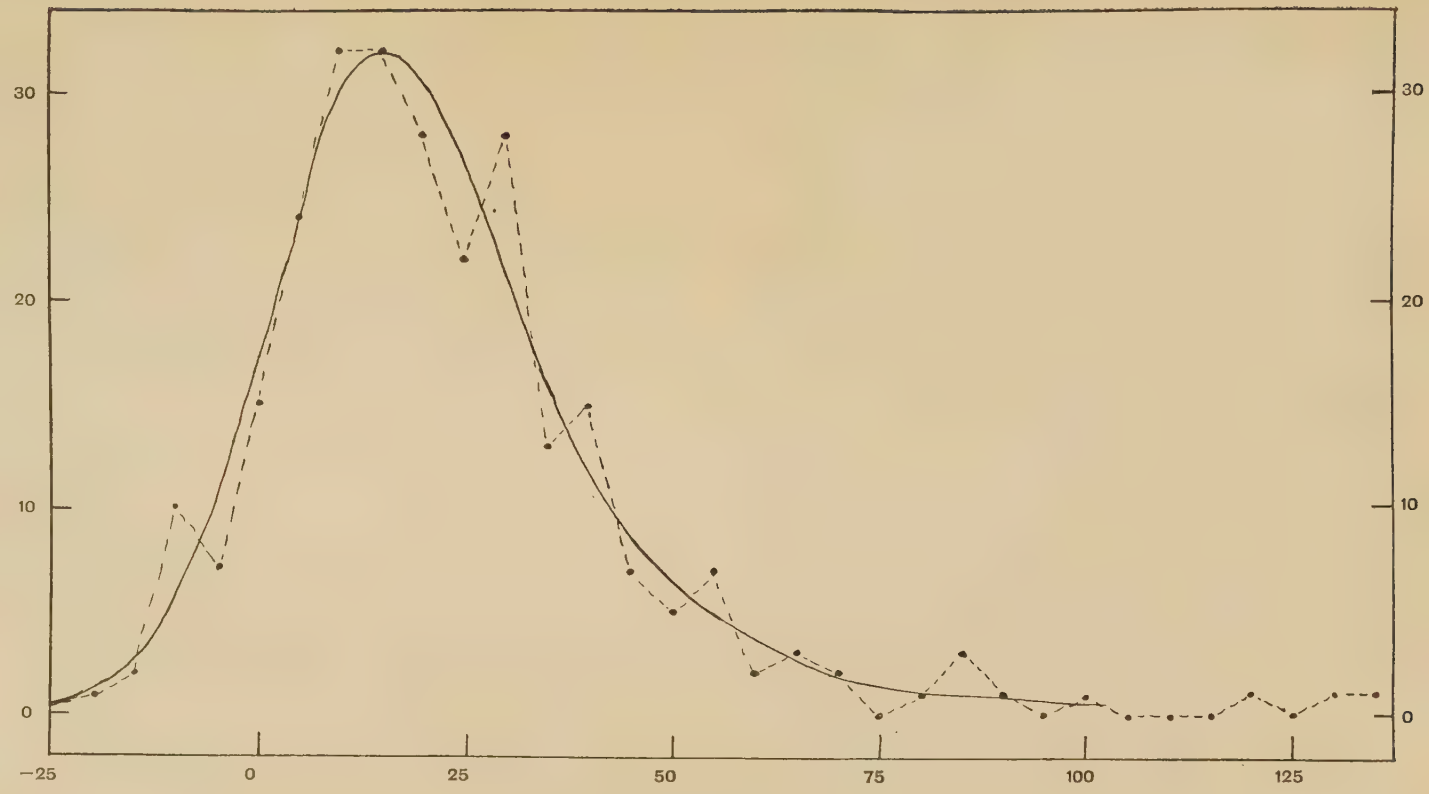


Fig. 1.—Distribution of Stars in Greenwich Catalogue.

integrated between these limits, or

$$\frac{1}{2h^2}(y_1 - y_2).$$

Thus total positive and negative corrections in the case considered should be $\pm''\cdot029 \times 32 = \pm''\cdot928$.

The corrections actually applied are $+''\cdot813$ and $-''\cdot816$, so that the corrections adopted were a little too small. A revision of the corrections makes those at $+''\cdot045$, $+''\cdot040$, $+''\cdot035$, 9, 8, and 7, instead of 8, 7, 6 used, and those on the negative side of $''\cdot015$ slightly increased. The maximum might also be shifted from $+''\cdot015$ to $+''\cdot016$. These changes have not been made as they were not discovered till the paper was nearly finished and as they will have only a small effect.

In Table II. the first five columns give the *data*. Column 1 gives the number in the Greenwich volume of Parallaxes, or the B.D. number for stars determined since its publication. Columns 2, 3, 4, 5 give the observed parallax, apparent magnitude, spectral type, and proper motion of each star. The proper motions are absolute proper motions, but have been in some cases derived from the relative proper motions. Columns 6, 7, 8 give the corrected parallax and deduced absolute magnitudes and velocities in kilometres per second perpendicular to the line of sight. Parallaxes and proper motions are given in units of $''\cdot001$ for convenience of printing and clearness in displaying the figures.

TABLE II.

No.	π obsd.	m.	Sp.	p.m.	π corrd.	M.	V.
1	6	9·2	Fo	348	16	5·2	103
2	23	6·4	G5	343	20	2·9	82
3	31	7·4	F8	321	25	4·1	61
4	6	9·5	..	184	16	5·5	55
5	13	7·4	G5	404	17	3·6	113
6	3	8·9	G5	329	14	4·6	111
7	15	9·4	K	754	18	5·7	199
8	17	6·7	Go	221	19	3·0	55
10	19	7·3	G5	226	19	3·7	56
12	38	6·7	G5	392	31	4·1	60
13	16	8·9	Go	282	18	5·2	74
15	22	6·7	F8	394	20	3·2	93
16	43	9·3	..	569	35	7·0	77
17	− 1	9·0	..	345	12	4·4	137
19	− 1	10·0	..	225	12	5·4	89
20	5	11·3*	..	234	15	7·1	74
22	4	10·0	..	214	15	5·9	68
23	7	9·0	F8	352	17	5·2	98

* Phot mags.

TABLE II.—*continued.*

No.	π obsd.	m.	Sp.	p.m.	π corrd.	M.	V.
24	8	6·9	..	250	17	3·1	69
25	17	10·3	..	213	19	6·7	53
26	22	9·2	Ko	260	20	5·7	62
27	72	9·2	Ko	283	64	8·3	21
28	4	9·5	..	260	15	5·4	82
29	70	8·3	K5	612	62	7·3	47
30	13	8·4	F8	208	17	4·6	58
31	− 7	10·3	..	220	11	5·5	95
32	21	7·3	F8	345	20	3·8	82
33	59	8·1	G5	313	46	6·4	32
34	34	8·2	G5	241	28	5·4	34
35	12	9·6	..	210	17	5·8	59
36	21	10·0	..	208	20	6·5	49
37	21	7·8	G5	253	20	4·3	61
38	21	8·9	G5	366	20	5·4	87
39	27	9·6	..	214	22	6·4	46
40	14	8·6	Go	309	17	4·8	86
41	18	10·3	..	262	19	6·6	65
42	35	6·3	F8	330	29	3·6	54
43	30	10·3	..	251	25	7·3	47
44	23	6·4	F2	180	20	2·9	43
46	21	8·0	F8	214	21	4·7	51
47	1	8·7	Go	180	13	4·3	66
48	14	7·7	F8	280	17	3·9	78
49	23	10·0	..	284	20	6·5	67
50	23	7·3	Go	251	20	3·8	60
51	12	8·8	G	186	17	5·0	52
52	− 4	8·9	Go	379	11	4·1	172
53	10	8·8	Go	231	17	5·0	64
54	23	8·8	G5	344	20	5·3	82
55	43	7·6	G5	427	35	5·1	58
57	34	8·6	Go	251	28	5·8	42
58	29	9·6	..	252	24	6·5	50
59	16	9·0	..	207	18	5·3	55
60	44	7·8	Go	221	36	5·5	29
61	37	5·6	F8	602	30	3·0	95
62	18	10·4*	..	199	19	6·8*	50
63	27	8·6	G5	215	22	5·4	46

* Phot. mags.

TABLE II.—*continued.*

No.	π obsd.	m.	Sp.	p.m.	π corrd.	M.	V.
64	17	6·8	Go	268	19	3·2	67
65	−10	7·9	..	266	11	3·1	115
66	21	10·0	..	485	20	6·5	115
67	3	9·4	G5	321	14	5·1	109
68	37	10·0	..	357	30	7·4	56
69	13	10·6*	..	352	17	6·8*	89
70	16	8·4	G5	258	18	4·7	68
71	56	6·5	G5	485	46	4·8	50
73	15	9·3	..	204	18	5·6	54
74	0	10·3	..	451	13	5·9	164
75	49	7·6	F5	298	40	5·7	35
76	15	8·0	Go	509	18	4·3	134
77	6	8·6	G5	260	16	4·6	77
78	16	8·6	G5	576	18	4·9	152
79	24	10·3	..	229	21	7·0	52
80	33	8·9	Ko	508	27	6·0	89
81	22	9·3	..	221	20	5·8	52
82	70	9·6	..	1056	62	8·6	81
83	91	8·9	K2	1364	85	8·5	76
84	87	9·1	K2	1386	81	8·7	81
85	25	7·8	Go	209	21	4·5	47
86	49	10·3	..	313	40	8·3	37
87	16	8·1	F5	209	18	4·4	55
88	41	9·6	..	1066	33	7·2	146
89	29	7·6	G5	323	24	4·5	64
90	58	9·3	..	445	48	7·7	44
91	58	8·8	K2	352	48	7·2	35
92	32	10·3	..	241	26	7·4	44
93	− 6	7·8	F5	218	11	3·0	94
94	2	10·3	..	239	14	6·0	81
95	21	9·6	..	464	20	6·1	110
96	25	8·3	F8	237	21	5·0	54
97	26	9·0	G5	293	22	5·8	63
98	54	9·8	..	379	45	8·1	40
99	33	9·3	..	171	27	6·5	29
100	9	8·7	Go	199	17	4·9	55
101	24	10·3	..	307	21	7·0	70
102	43	6·1	G5	415	35	3·8	56

* Phot. mags.

TABLE II.—*continued.*

No.	π obsd.	m.	Sp.	p.m.	π corrd.	M.	V.
103	55	10·3	..	593	46	8·6	61
104	7	8·3	Go	197	17	4·5	55
105	22	8·5	G5	262	20	5·0	62
106	12	7·1	Go	202	17	3·3	56
107	20	10·3	..	292	20	6·8	69
108	33	9·0	G5	355	27	6·1	62
110	82	7·2	K5	395	76	6·6	25
111	125	9·3	Ma	2954	120	9·7	117
112	33	7·2	F8	210	27	4·3	37
114	23	9·1	G5	327	20	5·6	78
116	21	9·8	..	220	20	6·3	52
117	36	10·3	..	258	29	7·5	42
118	1	8·7	G5	285	13	4·3	104
119	15	8·4	F8	296	18	4·7	78
120	35	6·3	F2	215	29	3·6	35
121	34	8·2	G5	485	28	5·4	82
122	35	9·5	..	383	29	6·8	63
123	11	8·2	F8	446	17	4·4	124
124	11	9·5	..	190	17	5·7	53
125	1	7·2	Go	210	13	2·8	77
126	15	9·6	..	303	18	5·9	80
127	39	10·3	..	237	32	7·8	35
128	13	9·2	G5	251	17	5·4	70
129	33	8·2	Go	409	27	5·5	72
131	2	8·8	G5	694	14	4·5	235
132	42	9·6	..	315	34	7·3	44
134	16	9·6	..	278	15	5·5	88
135	−12	9·7	G5	243	11	4·9	105
136	41	10·3	..	425	33	7·9	61
139	42	10·3	..	413	34	8·0	57
140	19	8·0	G5	287	19	4·4	72
143	29	10·3	..	273	24	7·2	54
144	46	13·0*	..	587	37	10·8*	75
145	34	7·6	F5	281	28	4·8	47
146	61	10·3	..	591	51	8·8	55
148	21	11·5*	..	957	20	8·0*	227
149	7	5·7	Go	296	17	1·9	82
150	25	6·7	Go	413	21	3·4	93

* Phot. mags.

TABLE II.—*continued.*

No.	π obsd.	m.	Sp.	p.m.	π corrd.	M.	V.
151	31	9·8	..	284	25	6·8	54
152	39	9·0	..	273	32	6·5	40
153	25	9·2	..	210	21	5·9	47
154	14	8·9	Ko	206	17	5·1	57
155	− 4	10·0	..	204	11	5·2	88
157	20	9·5	..	386	20	6·0	91
158	20	9·0	G_5	265	20	5·5	63
159	16	8·4	Go	203	18	4·7	54
160	51	6·5	G_5	251	42	4·6	28
161	40	8·6	G_5	246	32	6·1	36
162	18	9·2	K	233	19	5·6	58
163	34	9·3	K_5	326	28	6·5	55
164	44	9·6	..	224	36	7·3	29
165	38	7·4	G_5	265	31	4·8	40
166	30	9·6	..	261	25	6·6	49
168	12	9·1	K	280	17	5·3	78
169	14	10·0	..	212	17	6·2	59
170	41	7·8	G_5	301	33	5·4	43
171	91	8·9	K_5	504	85	8·5	28
172	86	11·5*	..	482	80	11·0*	28
173	44	5·0	Fo	270	36	2·7	36
175	11	6·4	G_5	292	17	2·6	82
176	45	7·6	G_5	522	37	5·4	67
178	3	6·0	F_2	216	14	1·7	73
179	25	9·6	..	255	21	6·3	57
180	29	4·8	F_5	252	24	1·7	50
181	16	9·3	..	285	18	5·6	74
182	19	10·3	..	223	19	6·7	55
185	68	6·3	Ko	525	59	5·2	42
186	18	7·4	Go	189	19	3·8	47
190	247	9·3	Mb	1270	245	11·3	25
192	8	4·9	F_5	304	17	1·1	85
193	62	9·5	..	340	52	8·0	31
194	15	10·3	..	243	18	6·6	64
195	32	10·0	..	214	26	7·1	39
196	51	8·4	Ko	333	42	6·5	37
197	60	4·9	F_5	251	50	3·4	24
198	33	6·1	F_5	272	27	3·3	47

* Phot. mags.

TABLE II.—*continued.*

No.	π obsd.	m.	Sp.	p.m.	π corrd.	M.	V.
199	7	9·6	..	279	17	5·8	78
200	9	8·2	G	211	17	4·4	59
201	23	5·0	F5	255	20	1·5	61
202	60	5·0	F2	359	50	3·5	34
204	4	10·0	..	455	15	5·9	144
205	137	3·7	F5	632	133	4·3	23
206	18	10·3	..	215	19	6·7	54
207	32	9·8	..	357	26	6·9	74
208	29	10·3	..	220	24	7·2	44
209	2	8·1	G5	222	14	3·8	75
210	20	9·8	..	307	20	6·3	73
211	15	9·3	..	213	18	5·6	54
212	8	7·3	Go	329	17	3·5	91
213	2	9·8	..	348	14	5·5	118
217	11	9·3	..	246	17	5·5	69
218	32	10·0	..	392	26	7·1	72
221	168	4·8	Ko	1840	165	5·9	53
222	55	8·0	Ko	210	45	6·3	22
223	8	10·0	..	272	17	6·2	76
224	37	8·7	F8	225	30	6·1	36
227	2	8·1	G	218	14	3·8	74
231	59	9·3	..	501	49	7·8	48
232	17	9·5	..	256	19	5·9	64
233	74	6·1	F8	533	66	5·2	38
234	12	10·0	..	334	17	6·2	93
235	46	6·1	Ko	244	37	3·9	31
236	41	7·6	G5	657	33	5·1	94
237	13	10·0	..	192	17	6·2	54
239	29	10·3	..	414	24	7·2	82
240	48	7·9	G5	709	39	5·9	86
241	− 5	9·0	F8	274	11	4·2	118
242	7	8·7	..	214	17	4·9	60
243	26	8·8	Ko	532	22	5·5	115
244	16	9·5	..	227	18	5·8	60
246	15	9·0	Ko	257	18	5·3	68
247	30	8·1	G5	250	25	5·1	47
249	35	9·1	Ko	342	29	6·4	56
251	− 9	10·3	..	248	11	5·5	107
252	47	9·5	..	392	38	7·4	49

TABLE II.—*continued.*

No.	π obsd.	m.	Sp.	p.m.	π corrd.	M.	V.
253	38	8·4	G5	305	31	5·8	46
254	29	7·5	G5	459	24	4·3	91
255	38	7·8	Go	301	31	5·2	46
258	21	7·7	G5	238	20	4·2	56
260	− 7	9·3	..	210	11	4·5	91
262	17	8·8	G5	228	19	5·2	57
265	106	6·6	K2	321	101	6·6	15
65°, 3	18	8·2	..	195	19	4·6	49
82°, 16	20	10·3	..	273	20	6·8	64
68°, 67	39	8·1	G5	265	32	5·6	39
82°, 38	23	9·5	..	324	20	6·0	77
64°, 212	30	8·4	G5	246	25	5·4	46
66°, 145	47	7·6	G5	719	38	5·5	90
67°, 330	6	10·3	..	256	16	6·3	76
75°, 255	22	10·3	..	209	20	5·8	49
64°, 606	18	10·3	..	208	19	6·7	52
72°, 421	31	10·3	..	221	25	7·3	42
76°. 404	44	9·2	..	470	36	7·0	62
65°, 3825*	9	11·9†	..	303	17	8·1†	85
64°, 949	26	6·3	G5	464	22	3·1	100
69°, 724	24	6·0	Ko	212	21	2·7	48
74°, 618	30	9·6	..	237	25	6·6	45
67°, 910	11	10·3	..	365	17	6·5	102
65°, 1092	42	8·8	G5	256	34	6·6	36
63°, 1439	3	8·1	G5	253	14	3·8	85
80°, 662	2	9·3	..	224	14	5·0	75
61°, 2068	133	8·6	K2	770	131	9·2	28
73°, 943	− 8	10·0	..	242	11	5·2	104
75°, 839	− 6	9·6	..	249	11	4·8	107
75°, 855	31	9·3	..	305	25	6·3	57
68°, 1345	− 1	8·4	..	641	12	3·8	255
67°, 1498	26	7·5	Go	617	22	4·2	133
76°, 934	40	6·8	G5	278	32	4·3	41

(7) In order to show the effect of this correction, the stars of unknown spectral type which form a group of apparent magnitude generally between $9^{m}\cdot0$ and $10^{m}\cdot3$ have been taken, and the values of M and V calculated from the uncorrected as well as the corrected parallaxes.

* *Greenwich Ast. Cat.*, vol. i. .. † Phot. mags.

They were then arranged in groups according to size of parallax and the means taken. The results are shown in Table III.

TABLE III.

No. of Stars.	Parallax.		M.		V.	
	Uncorrected.	Corrected.	Uncorrected.	Corrected.	Uncorrected.	Corrected.
10	59	50	8·5	8·1	42	50
12	40	33	7·8	7·3	48	58
14	31	25	7·3	6·8	43	52
13	23	20	6·6	6·3	71	77
13	18	19	6·2	6·3	65	62
8	15	18	5·5	5·9	78	65
10	11	17	5·2	6·2	108	66
15	− 2	13	..	5·2	..	93*

The values of M derived from the uncorrected parallaxes diminish, and the values of V increase very considerably. Those derived from the corrected parallaxes change much less, and perhaps not more than may be expected from the method of selection of the stars (p.m. 20″ a century) which necessarily only picks out the brightest and most swiftly moving of the more distant class.

(8) The mean magnitudes for the different types are :

F0–F5	3·4	17 stars.
F8	4·4	16 ,,
G0	4·2	24 ,,
G5	4·9	50 ,,
K0(g)	3·3	2 ,,
K0(d)	6·0	11 ,,
K2–K5(d)	7·8	9 ,,

The distribution according to absolute magnitudes of the stars of different spectral class is shown in Table IV.

TABLE IV.

Absolute Magnitude.	F0–F5.	F8.	G0.	G5.	K0.	K2–K5.	Ma.	Unknown.
1·0–1·9	4	..	1					
2·0–2·9	2	..	1	2	1			
3·0–3·9	6	6	7	7	1	..	..	2
4·0–4·9	2	7	9	15	..	..	..	9
5·0–5·9	3	2	2	16	6	..	..	43
6·0–6·9	..	1	..	3	4	3	..	38
7·0–7·9	..	..	..	..	..	1	..	23
8·0–8·9	..	..	..	..	1	4	..	6
9·0–9·9	..	..	..	..	..	1	1	

* No. 131 with observed $\pi = ''\cdot 002$, corrected $\pi = ''\cdot 014$, and $M = 4^{m}\cdot 5$ V = 235 was omitted from this group.

There is also a well-known Mb star of magnitude 11·3. Two other stars whose visual magnitudes are not known have photographic magnitudes $>10^{m}\cdot0$. Attention may be drawn to a faint star at R.A. $2^{h}\ 51^{m}$, Dec. 89° 26′, which, judging from its colour, is of Type A, and whose absolute magnitude is $7^{m}\cdot1$.

(9) In Table V. the mean velocities perpendicular to the line of sight are given for the stars whose parallaxes lie between specified limits, the subscript numbers denoting the number which have contributed to each mean.

TABLE V.

Limits of Parallax.	Fo–F5.	F8–Go.	G5.	Ko–K5.	Unknown.
″> ″·100	19_{1}	..	..	32_{3}	..
·050 to ·100	24_{2}	39_{1}	..	46_{6}	49_{1}
·040 ,, ·050	35_{1}	..	37_{3}	26_{1}	46_{5}
·030 ,, ·040	..	52_{4}	57_{14}	35_{1}	61_{12}
·020 ,, ·030	47_{6}	70_{12}	67_{18}	72_{6}	59_{34}
·010 ,, ·020	81_{7}	81_{25}	98_{16}	92_{5}	89_{44}

The mean velocities increase rapidly for the small parallaxes. This is, to some extent, due to the fact that errors which make the parallax too small produce very large errors in the velocities. Taking the median instead of the mean to eliminate this effect, the last line of the table becomes 73, 74, 83, 65, 77.

This group consists of stars moving twice as fast as those with parallaxes greater than ″·040. As previously remarked, a result of this kind follows from the mode of selection of those stars for parallax determination which have proper motions greater than a definite limit.

(10) The stars whose parallaxes are greater than ″·050 and their cross velocities are as follows :—

π.	Vel.	π.	Vel.	π.	Vel.
″·245	25 km./sec.	″·085	28 km./sec.	″·062	47 km./sec.
·165	153 ,,	·081	86 ,,	·059	42 ,,
·133	19 ,,	·080	28 ,,	·053	24 ,,
·131	28 ,,	·076	25 ,,	·052	51 ,,
·120	117 ,,	·066	29 ,,	·051	55 ,,
·111	14 ,,	·064	21 ,,	·050	25 ,,
·085	76 ,,	·062	81 ,,		

The mean of these velocities is 48 km./sec., and 11 of the 20 have velocities less than 40 km./sec. Comparing these figures with those derived later in the paper from Professor Schlesinger's Catalogue of Parallaxes, it would appear that there are not many stars in the part of the sky observed at Greenwich whose parallaxes are greater than ″·050, but which have escaped notice on account of their small velocity and consequent small proper motion.

(11) The scarcity of stars of small velocity is rather surprising. There are only two with velocities less than 20 km./sec. (14 and 19), and if the Solar Motion taken as 20 km./sec. be subtracted, there are still only six or seven stars with velocities less than 20 km./sec. It was anticipated when the programme of observation was drawn up that a larger part of the apparent proper motions was due to the Solar Motion; the distribution of velocities is as follows :—

0 to 20 km./sec.	2	60 to 80 km./sec.	56
20 „ 40 „	33	80 „ 100 „	32
40 „ 50 „	35	100 „ 150 „	24
50 „ 60 „	52	over 150 „	9

(12) In view of Dr. Oort's results (*Groningen Publications*, No. 40), the directions of motion were determined as projected on the tangent plane at the pole. They did not show more than a very marked separation of the stars into the two streams. Two hundred and seven stars may be attributed to Stream I.; the R.A. of the Apex is 96°; 153 of the stars are moving within 30° of this direction. Thirty-two of the stars may be attributed to Stream II.; the Apex is at R.A. 260°; twenty-one of the stars are moving within 30° of this direction. The velocities in Stream II. are considerably less than those in Stream I. The results are essentially the same as those given in *Greenwich Astrographic Catalogue*, vol. iv., and are summarised in Table VI.

TABLE VI.

Number of Stars moving in Different Directions.

Stream I.		Stream II.	
348°, 356°	2	204° to 213°	4
0° to 19°	5	225° „ 233°	4
20° „ 39°	7	240° „ 260°	10
40° „ 59°	7	265° „ 285°	10
60° „ 69°	10	280° „ 300°	3
70° „ 79°	21	310° „ 317°	3
80° „ 89°	26	326°	1
90° „ 99°	43		
100° „ 109°	25		
110° „ 119°	18		
120° „ 129°	12		
130° „ 149°	20		
150° „ 176°	10		

(13) I have employed this method of applying a mean correction to parallaxes of different amounts to the Catalogue of Parallaxes published by Professor Schlesinger. I have selected stars of magnitude $6^{m}.5$ or brighter, and only those whose parallax is given with a probable error

of $\pm 0''\cdot010$ or less. Altogether 722 stars were taken, distributed as shown in the following table and fig. 2.

Parallax.	No.	Parallax.	No.	Parallax.	No.
$-''\cdot023$	1	$+''\cdot028$ to $+''\cdot032$	48	$+''\cdot083$ to $+''\cdot087$	6
$-''\cdot022$ to $-''\cdot018$	3	$+''\cdot033$,, $+''\cdot037$	50	$+''\cdot088$,, $+''\cdot092$	3
$-''\cdot017$,, $-''\cdot013$	3	$+''\cdot038$,, $+''\cdot042$	38	$+''\cdot093$,, $+''\cdot097$	1
$-''\cdot012$,, $-''\cdot008$	15	$+''\cdot043$,, $+''\cdot047$	22	$+''\cdot100$,, $+''\cdot125$	15
$-''\cdot007$,, $-''\cdot003$	21	$+''\cdot048$,, $+''\cdot052$	21	$+''\cdot125$,, $+''\cdot150$	8
$-''\cdot002$,, $+''\cdot002$	46	$+''\cdot053$,, $+''\cdot057$	19	$+''\cdot150$,, $+''\cdot175$	2
$+''\cdot003$,, $+''\cdot007$	75	$+''\cdot058$,, $+''\cdot062$	14	$+''\cdot175$,, $+''\cdot200$	4
$+''\cdot008$,, $+''\cdot012$	66	$+''\cdot063$,, $+''\cdot067$	12	$+''\cdot203$ & $+''\cdot204$	2
$+''\cdot013$,, $+''\cdot017$	81	$+''\cdot068$,, $+''\cdot072$	15	$+''\cdot300$, 310, 312, 315	4
$+''\cdot018$,, $+''\cdot022$	59	$+''\cdot073$,, $+''\cdot077$	7	$+''\cdot371$	1
$+''\cdot023$,, $+''\cdot027$	60	$+''\cdot078$,, $+''\cdot082$	12	$+''\cdot758$	1

The probable error has been taken as $\pm''\cdot068$, making $\frac{1}{2h^2}\cdot\frac{1}{\Delta x}=''\cdot020$ when $\Delta x=''\cdot005$, and corrections have been calculated by the formula

$$\bar{\epsilon}=\frac{1}{2h^2}\cdot\frac{1}{y}\cdot\frac{dy}{dx}=''\cdot020\frac{\Delta y}{y}.$$

The corrections found are such that parallaxes

$-''\cdot023$ to $-''\cdot012$	are made	$=+''\cdot005$
$-''\cdot011$,, $-''\cdot007$	,,	$=+''\cdot006$
$-''\cdot006$,, $-''\cdot003$	,,	$=+''\cdot007$
$-''\cdot002$,, $-''\cdot001$	,,	$=+''\cdot008$
$-''\cdot000$,, $+''\cdot002$	,,	$=+''\cdot009$
$+''\cdot003$,, $+''\cdot007$	,,	$=+''\cdot010$
$+''\cdot008$,, $+''\cdot010$	,,	$=+''\cdot011$

Parallaxes of amount $''\cdot011$ to $''\cdot014$ are unaltered.
To parallaxes $''\cdot015$ to $''\cdot017$ a correction $-''\cdot001$ is applied.

$''\cdot018$,, $''\cdot024$	,,	$-''\cdot002$	,,
$''\cdot023$,, $''\cdot027$	,,	$-''\cdot003$	,,
$''\cdot028$,, $''\cdot100$	,,	$-''\cdot004$	,,
$''\cdot100$,, $''\cdot125$	,,	$-''\cdot003$	,,
$''\cdot125$,, $''\cdot150$	,,	$-''\cdot002$	,,
$''\cdot150$,, $''\cdot204$	,,	$-''\cdot001$	,,

The total of the positive and negative corrections is nearly $''\cdot020\times74$, or $1''\cdot480$.

The parallaxes thus corrected are distributed as follows :—

$''\cdot005$ to $''\cdot009$	81	$''\cdot025$ to $''\cdot049$	176	$''\cdot150$ to $''\cdot201$	8
$''\cdot010$,, $''\cdot014$	187	$''\cdot050$,, $''\cdot075$	66	$''\cdot300$,, $''\cdot315$	4
$''\cdot015$,, $''\cdot019$	82	$''\cdot075$,, $''\cdot100$	21	$''\cdot371$	1
$''\cdot020$,, $''\cdot024$	81	$''\cdot100$,, $''\cdot150$	17	$''\cdot758$	1

(14) The corrections have the greatest effect on the stars of types Oe5 to B5 and M stars which are given in detail. The first column

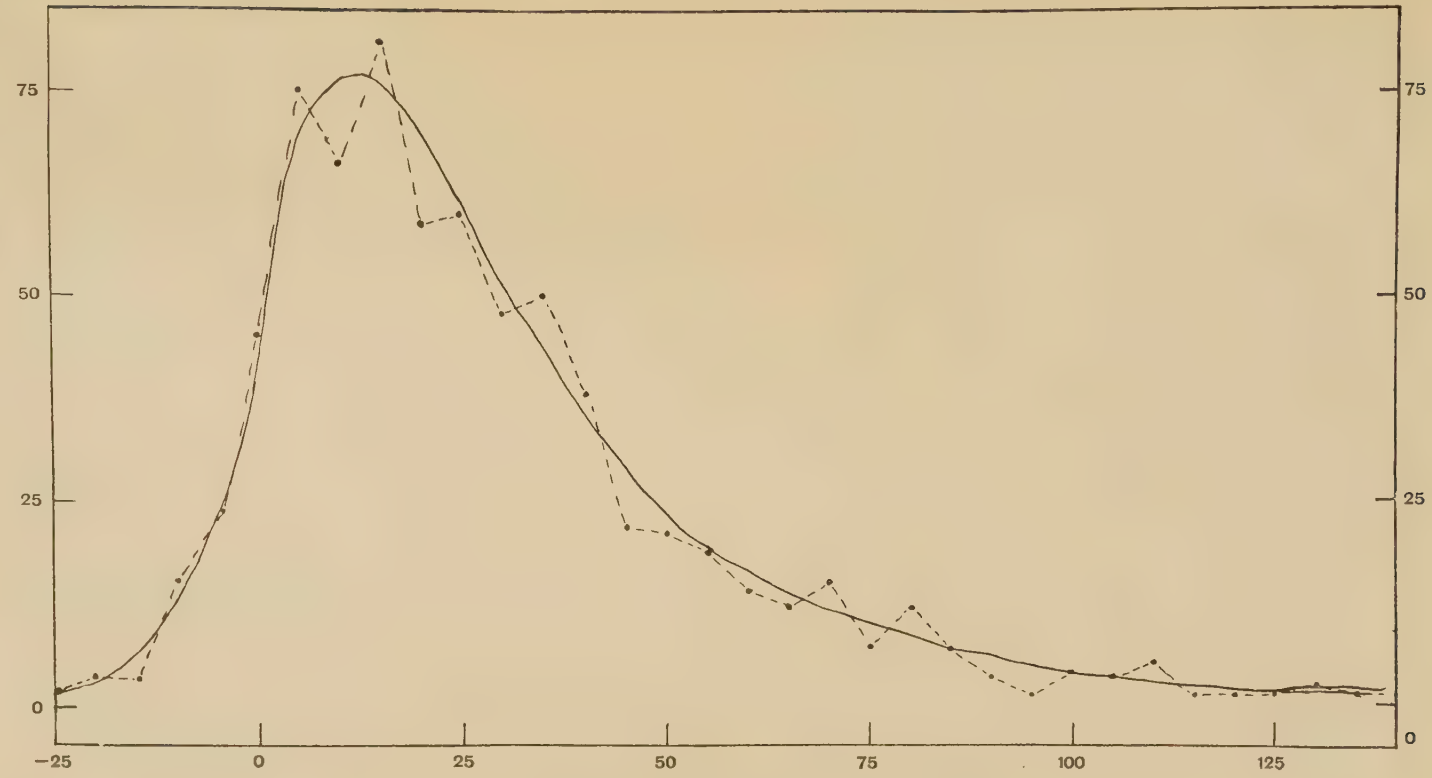


Fig. 2.—Distribution of Stars in Schlesinger's Catalogue.

gives the number in Schlesinger's Catalogue, the next columns give the uncorrected and corrected values of the parallax and of absolute magnitude and velocity perpendicular to the line of sight deduced from the corrected parallaxes and the apparent magnitudes and proper motions given by Schlesinger.

TABLE VII.

Types Oe5–B5.

No.	Sp. Type.	π Observed.	π Corrected.	M. m	V.
28	B3	−21	5, 3	−2·8	24
58	Bop	36	32, 15	−0·3	5
120	B3	1	9, 5	−2·4	23
223	B5	15	14, 8	+0·4	16
237	B1	13	13, 7	−0·5	10
244	B5	12	12, 6	+0·8	24
245	B5p	20	18, 7	+0·1	15
257	B5p	7	10, 5	−2·0	25
287	B3	− 8	6, 4	Var.	14
296	B3p	15	14, 8	−0·3	15
405	B3	0	9, 5	−1·4	4
408	B3	3	10, 5	−1·1	2
422	B3	14	14, 7	−1·0	28
446	B2	19	17, 7	−2·1	5
449	B2	−12	5, 3	−1·8	12
459	Bo	9	10, 4	−2·5	3
463	Oe5	−14	5, 3	−1·1	7
464	Bo	5	10, 5	−3·2	2
466	B3p	− 1	8, 5	−2·5	15
469	Bo	− 9	6, 4	−2·3	2
470	B3	7	10, 5	−0·1	15
560	Oe5	− 2	6, 5	−1·4	7
931	B5p	− 3	6, 5	−2·2	47
947	B1	8	10, 5	−3·5	26
982	B2	9	10, 5	−3·8	24
1010	B3	− 4	6, 5	−4·2	91
1316	B3	− 7	6, 4	−1·0	14
1514	Bo	3	10, 5	+0·5	8
1562	B2p	4	10, 5	+0·8	7
1580	B5	1	9, 5	−1·2	16
1667	B3p	16	15, 7	0·3	15
1689	B1	7	10, 5	−1·7	6
1729	B5	22	20, 8	−1·6	48
1740	Od	5	10, 5	+0·2	13
1802	B3	3	10, 5	−1·4	17
1861	Bp	29	25, 12	+3·2	1

The application of the corrections has increased the mean parallax of these stars from +″·0055 to +″·0110. The mean absolute magnitude of these stars is $-1^{m}\cdot23$ and the mean cross velocity 14 km./sec.

Dr. Jackson pointed out that this arose owing to the distribution of these B stars being different from that of the general mass of stars from which the correction was deduced, and that the correction should be derived from these 36 stars alone. This is a small number from which to determine a correction, but the results would be approximately those given after the comma in the column "π corrected." Roughly speaking, the parallaxes are halved. The mean absolute magnitude is increased from $-1^{m}\cdot23$ to $-2^{m}\cdot35$, and the velocity perpendicular to the line of sight from 14 to 29 km./sec. It is, I think, certain that the second solution gives more correct values of the smaller parallaxes which become 5 or 6 instead of 9 or 10, but it is possible that the larger ones have been reduced too much. With this small number of stars the number of positive errors may well differ somewhat from the number of negative ones. The smaller values are in fair agreement with Campbell's results from radial velocities, the larger ones with Plaskett's, so that no definite criterion can be obtained in this way. Both values for the parallax are generally smaller than those given by Charlier.

Similar criticism applies, but with much less force, to other groups.

TABLE VIII.

M *Stars.*

No.	Sp. Type.	π Observed.	π Corrected.	M. m	V.
10	Ma	− 9	6	−1·2	77
64	Ma	− 2	6	+0·2	20
75	Ma	45	41	0·4	25
160	Mb	12	12	1·0	25
186	Mb	12	12	1·3	8
195	Ma	12	12	−1·8	32
407	Ma	6	9	0·5	19
440	Mb	4	8	0·4	29
485	Ma	17	15	Var.	9
512	Ma	14	14	Var.	21
550	Ma	2	8	Var.	21
598	Ma	3	8	0·2	11
601	Mb	4	8	0·4	11
634	Mb	2	8	0·3	9
687	Ma	25	22	2·5	25
716	Ma	− 3	6	0·2	17
798	Ma	− 4	6	−0·4	31
821	Mb	− 9	6	−0·1	16
827	Ma	19	17	2·4	27

TABLE VIII.—*continued.*

No.	Sp. Type.	π Observed.	π Corrected.	M. m	V.
862	Ma	22	20	0·6	10
873	Ma	7	10	−0·8	88
942	Mb	− 9	6	Var.	7
958	Ma	10	11	−1·1	205
1015	Ma	1	7	0·2	47
1084	Mb	− 7	6	−0·1	
1127	Ma	22	20	2·0	18
1152	Ma	40	36	0·7	21
1171	Ma	12	12	0·8	69
1202	Mb	15	14	1·5	19
1240	Mb	− 2	6	−2·6	24
1463	Ma	13	13	0·2	61
1634	Ma	6	10	0·8	36
1682	Ma	10	11	0·0	9
1804	Mb	16	15	−1·5	72
1858	Ma	14	14	0·9	16

The application of the corrections has increased the mean parallax from +″·009 to +″·012. The mean absolute magnitude is $+0^{m}\cdot25$. There is a large range in the velocities—the mean is 33 km./sec. and the median 22 km./sec.

(15) Using the corrected parallaxes and treating the stars of each spectral type in the same manner, the mean absolute magnitudes and cross velocities in kilometres per second are determined and given in Table IX. The median as well as the mean is given for the velocities, as errors in small parallaxes produce large errors in the velocities.

TABLE IX.

Type.	No.	M.	V.		Type.	No.	M.	V.	
Oe5–B5	32	−1·2	14	13	G5	65	+2·4	51	34
B8 and B9	13	+0·1	16	12	Ko (giants)	143	+0·7	36	28
Ao ,, A2	94	+0·5	16	17	Ko (dwarfs)	17	+5·8	38	35
Fo ,, F2	47	+0·9	34	27	K2 and K5 (g)	38	+0·3	29	28
F5	77	+2·4	41	34	K2 ,, K5 (d)	4	+7·0	71	70
F8	37	+3·2	43	37	M (giants)	31	+0·2	33	22
Go	68	+2·7	48	39					

The giants and dwarfs are clearly separated for the K stars.

The distribution of the stars of the several classes in absolute magnitude is shown in Table X. Under the heading −3 are included all stars from $-3^{m}\cdot0$ to $-3^{m}\cdot9$, etc.

TABLE X.

M.	−3.	−2.	−1.	−0.	+0.	+1.	+2.	+3.	+4.	+5.	+6.	+7.
Oe5–B5	3	7	11	4	7	..	..	1				
B8, B9	..	..	3	..	4	4	..	1				
A0–A2	1	1	8	21	31	21	10	1				
F0–F2	..	..	4	2	6	13	10	10	1			
F5	..	2	..	5	5	9	25	25	6			
F8	1	..	..	1	..	4	6	15	10	1		
G0	..	5	1	3	6	3	6	21	21	2		
G5	..	..	5	7	8	7	9	9	8	9	3	
K0	..	3	13	23	44	34	15	8	2	10	7	
K2 and K5	..	..	7	8	14	6	2	1	..	..	1	3
M	..	1	4	4	16	3	3					

Rigel M = $-4^{m}\cdot7$ has been left out of B8 group, and
Canopus M = $-5^{m}\cdot9$,, ,, ,, F0 group.

The stars in the group A0 to A2 are distributed in a normal error curve with its maximum at $+0^{m}\cdot5$; 70 per cent. of the stars are between $-0^{m}\cdot5$ and $+1^{m}\cdot5$. The point of maximum moves towards a smaller magnitude till we come to G0. The magnitudes are spread out on the bright side, but stop suddenly on the faint side, probably due to the limit $6^{m}\cdot5$ apparent magnitude in the selection of the list. Comparison with Table IV. illustrates this point. When we reach the K0 stars there is a nearly normal distribution of the giants about the magnitude $0^{m}\cdot7$ with a mean dispersion of $\pm1^{m}\cdot0$, and dwarfs appear between the magnitudes $5^{m}\cdot0$ and $6^{m}\cdot6$. This is in accordance with Table IV. The absolute magnitudes of the dwarf stars agree well with previous investigations, and the giants agree for K stars and later types, but I do not find an indication of any maximum showing giants of types F and G, such as was found by Adams in his paper on "Spectroscopic Parallaxes," in 1917 (*Ap. J.*, vol. xlvi.).

The distribution of the velocities for different types of spectrum is given in Table XI. In conjunction with Table IX., it shows that the velocities of giant stars of later type are considerably greater than those of earlier type, in accordance with results previously obtained from radial velocities.

TABLE XI.

Vel.	>100.	75–99.	50–74.	40–49.	30–39.	20–29.	10–19.	0–9.
Oe5–B9	0	1	1	3	0	7	15	17
A0–A2	3	1	5	8	8	17	32	17
F0–F8	11	9	20	23	24	25	32	15
G0–G5	13	10	24	15	15	26	17	10
K0 (g)	13	6	23	12	25	20	36	21
K0 (d)	..	1	2	4	3	6	1	0
K2–K5 (g)	1	2	2	4	6	3	13	7
K2–K5 (d)	..	2	1	1				
M (g)	1	2	3	1	3	10	9	5

(16) This method of correcting parallaxes depends on the existence of fairly long series of observations made under similar conditions, so that they form a homogeneous group. It is not fulfilled strictly in the case of the parallaxes of Schlesinger's Catalogue. Better results would have been obtained if the results of the different Observatories contributing to the Catalogue had been treated separately; or, as Dr. Jackson pointed out, if each class of stars to be subsequently discussed had been dealt with by itself. Still the value of the correction is sufficiently indicated. The method is applicable to all homogeneous series of observations in which the probable error is known and where it is an appreciable fraction of the true range in the quantities determined.

In conclusion, I wish to express my thanks to Mr. Martin for the help he has given me in computation and in sorting out the materials employed in this paper.

Note on the Period of the Variable Star 30.1926 *Ophiuchi.*

By H. G. Scott Barrett.

(*Communicated by the Radcliffe Observer.*)

The variability of this star, whose place for 1926·0 is $18^h\ 32^m\ 26^s$, $+7°37'·5$, was established as a result of an examination of the photographic plates of the region of Kapteyn Area No. 3 Special, taken in the ordinary course of the proper motion work undertaken during recent years at the Radcliffe Observatory, Oxford. Announcements to this effect have already appeared in *The Observatory* for August 1926, pp. 242–43, and in the *Astronomische Nachrichten*, No. 5459.

In addition to the observations made at Greenwich and published in the note in *The Observatory*, a short, though valuable, series of observations has been kindly communicated by the Harvard College Observatory.

The observations thus rendered available are comparatively few in number and are scattered over an interval of thirty years. A cursory examination of these observations indicated that they might well be represented by a period of the order of a year, the variation being apparently of the ordinary long-period type.

Maxima occurring at about the following dates appear to be fairly well recognisable :

1899·75	E=−26
1914·2	−12
1922·4	− 4
1923·5	− 3
1925·5	− 1
1926·55	0

The representation of these dates by the formula :

$$\begin{aligned}\text{Maximum} &= 1926{\cdot}547 + 1{\cdot}0299\text{E} \\ &= 1926 \text{ July } 20 + 376^{\text{d}}\text{E} \\ &= \text{J.D. } 2424717 + 376^{\text{d}}\text{E}\end{aligned}$$

is extremely close.

With the aid of this formula all the photographic observations to hand have been combined to form a mean light-curve. As a result it can be stated that all the observations are satisfactorily represented and no sensible discordances are revealed, except in the cases of a few observations which are admittedly of a rather doubtful character. The variation appears to be confined within the limits 10·5 magnitude and 16 magnitude. The exact position of the minimum is not very well shown, but it would appear to follow the maximum by somewhat more than six months, perhaps seven. The fall in brightness disclosed by the recent visual observations confirms very closely the mean light-curve found from the photographic observations.

Some difficulty has been experienced in obtaining sufficiently reliable values for the visual magnitudes of the comparison stars, but the observations are clearly not inconsistent with a colour-index normally found for the spectral-type associated with variability of a long-period character.

The observations utilised in the preceding remarks are as follows :—

Photographic Observations.

Harvard.		Greenwich.	
	m		m
1896·50	12·2	1926·57	11·5
1897·61	12·0		
1899·74	10·5	F. A. Charts.	
·76	10·7	1903·71	14
1903·47	<15·5	1908·50	16·0
1904·58	13·8 ?	1910·42	15·9
1914·37	13·6	·59	16·3
·42	14·2	·59	<16·0
·47	<14·7		
·54	15·2	Radcliffe.	
1922·38	11·0	1911·51	<15·0
·55	12·7	1912·52	<15·2
1923·31	12·0	1926·54	11·2
·52	11·4	·57	11·2
·68	12 ?	·59	11·2
1925·47	10·8		
·48	10·9		

Visual Observations.

Radcliffe.		Dr. Steavenson.	
1926·57	9·6	1926·56	10·0
·57	10·0	·57	10·0
·58	9·8	·57	9·95
·59	10·1	·58	10·3
·59	9·8	·58	10·3
·59	10·3	·59	10·1
·60	10·0	·61	10·3
·61	10·2	·64	10·5
·64	10·4	·65	10·6
·67	10·5	·65	10·6
·70	10·8	·69	11·0
·73	11·9		

The Harvard and Radcliffe magnitudes are on the Harvard Photographic Scale. The Greenwich observation is on the scale of the Toulouse Astrographic Chart. The estimations made on the Franklin-Adams Charts appear to require corrections of the order of −0·5 magnitude to reduce them to the Harvard Scale. The visual magnitudes rest on the assumption that the photometric magnitude of the star B.D.+7°·3754 is 9·1.

I am indebted to Dr. W. H. Steavenson for permission to include his observations, which have been reduced to the same scale as the Radcliffe results.

Radcliffe Observatory, Oxford :
1926 *September* 29.

Erratum.

P. 636, *Note on the Nova in N.G.C.* 4303, line 5, *for* following *read* preceding.

LIST OF ADDITIONS

TO THE LIBRARY

OF THE SOCIETY

1925 JUNE 30 TO 1926 JUNE 30.

Serial Publications received in the regular course, and Reprints of Papers published in some of these Serials, are not included in this Annual List.

An asterisk (*) indicates that the work is an excerpt.

Abbot (Charles G.):

The Earth and the Stars.
(*Purchased.*) 8vo. London, 1926

Abraham (R. M.):

Surveying Instruments, their design, construction, testing and adjustment.
(*Author.*) 8vo. London, [1926]

Albany, Dudley Observatory:

Albany Zone Catalogue for the epoch 1900. . . . Catalogue of 8276 stars between 20° and 41° of S. declination, by Lewis Boss. Catalogue of 2800 stars between 2° of S. and 1° of N. declination, by Arthur J. Roy. Catalogues containing standard stars and miscellaneous star positions.
(Carnegie Institution Publications, No. 246.)
4to. Washington, 1918

Algiers, Observatoire:

——: Catalogue de 9997 étoiles comprises entre —17° 50′ et —23° 0′ de déclinaison 1855 pour l'équinoxe de 1900. (Publications, Vol. 8.)
(*Observatory.*) 4to. Paris, 1900

——: Catalogue Photographique du Ciel. Tome 1, fasc. 1, 2; tome 2, 3.
(*Observatory.*) 4to. Paris, 1923–24

Allegheny Observatory:

Publications. Vol. 6, Nos. 6, 7.
(*Observatory.*) 4to. Lancaster, Pa., 1925

Amateur Telescope Making:
[In 6 parts, by various authors.]
(*C. Ions.*) 8vo. [*s.l.*], 1926

Arendt (Theodor):
Heinrich Samuel Schwabe, der Entdecker der Sonnenfleckenperiode: Sein Leben und Wirken.
(*Author.*) 8vo. Dessau, [1925]

Barabacheff (N.):
——: *Études spectrophotométriques de la surface lunaire.
(*Author.*) 8vo. [Kharkov, 1926]

Barcelona, R. Academia de Ciéncias y Artes:
Memorias, tercera época. Vol. 19, No. 7.
(*Academy.*) 4to. Barcelona, 1925

Becker (Fr.):
Der veränderliche Stern ζ Geminorum.
(*Author.*) 8vo. Berlin, 1924

Benson (D. E.):
The Making of a Speculum.
(*Liverpool Astronomical Society.*) 8vo. Southport, 1913

Berlin, Astronomisches Recheninstitut:
*Jahresbericht, 1922–1924.
(*Recheninstitut.*) 8vo. Leipzig, 1925

Berlin, Preussische Akademie der Wissenschaften:
Geschichte des Fixsternhimmels. Abteilung I., Band 4. (R.A. 3^h.)
(*Purchased.*) 4to. Karlsruhe, 1925

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